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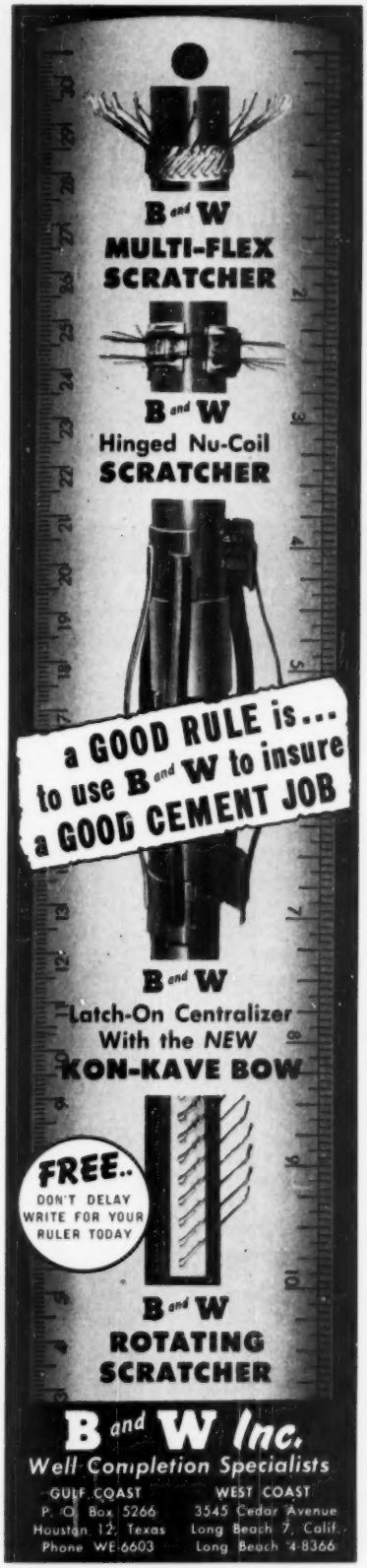
THIS MONTH'S COVER

The Petroleum Branch has a new Chairman this month, as Claude R. Hocott takes up the duties administered during the past year by Paul R. Turnbull. Formal transfer of the office takes place at the AIME Annual Meeting in Los Angeles. A review of Hocott's professional background and service to the Branch may be found on page 3, Section 2 of this issue.



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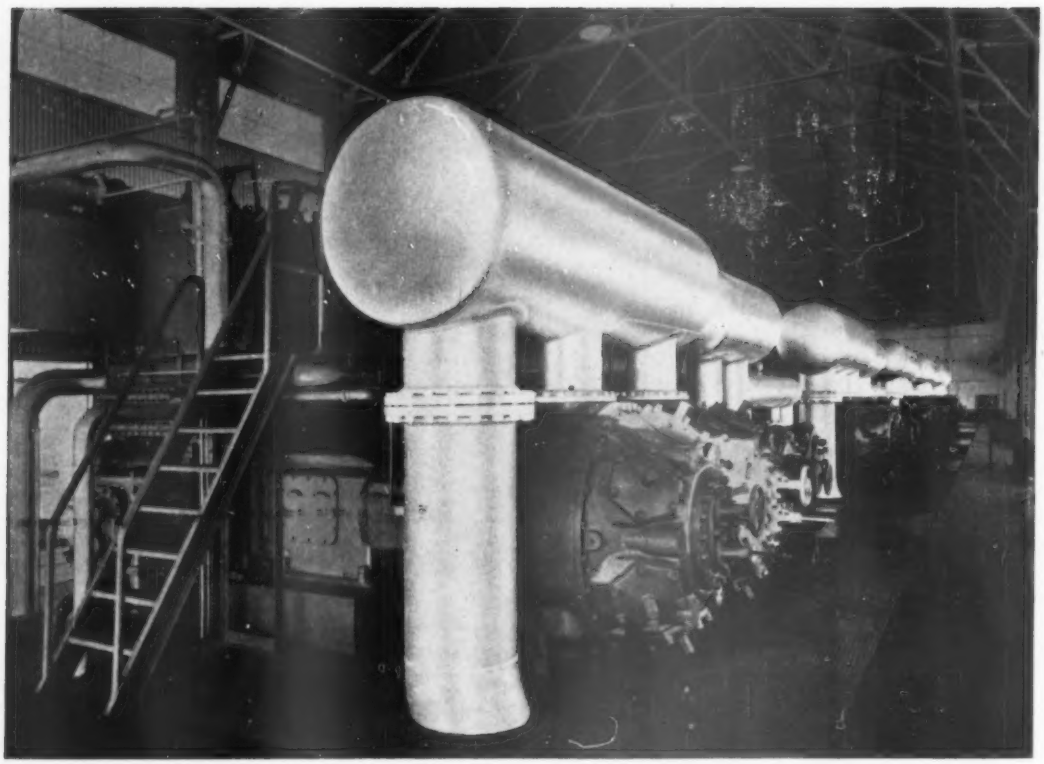

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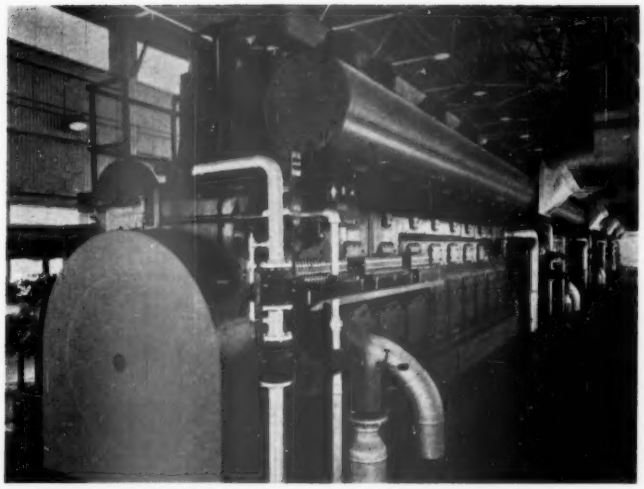

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Development and Operation of Water Injection Projects

By G. M. Stearns
British-American Oil Producing Co.

Here is a general view of water flooding and its uses in increasing rate and volume of production, and also a comparison of injection procedure under unitized and cooperative operations.

Water injection projects for increased oil recovery may be divided into two classes, which differ mainly because of the stage of depletion of the oil reservoir at the time the water injection is commenced. These classes are commonly designated as water-injection pressure-maintenance projects and pattern water floods.

WATER-INJECTION PRESSURE-MAINTENANCE PROJECTS

The production of oil from a reservoir usually causes a decline in pressure. Since in most instances the produced oil is accompanied by significant quantities of gas and water, the decline in pressure for a given amount of oil production may be much greater than if only the oil itself had been withdrawn from the reservoir. In certain localities, there is a plentiful supply of water, usually termed an aquifer, in direct contact with the oil reservoir and connected by means of a highly permeable channel to allow replacement of the oil as it is withdrawn. In such fields that have an active water drive, the pressure may be well maintained simply because the produced fluids are replaced by water which moves in through the permeable aquifer to take the place of oil and its attendant gas and water as produced. In a field of this type, pressure maintenance by water injection is never required because natural conditions are such as to accomplish the end that a man-made project would be designed to accomplish.

It is unfortunate that many fields do not have a sufficiently adequate natural water drive; and it is often desirable to inject water back into the reservoir of such a field as a means of replacing the reservoir fluids withdrawn while producing oil, and thus maintaining pressure to permit greater oil recovery and more economical operation of the wells.

The additional oil recovery will be obtained by the more effective flushing of water and by avoiding shrinkage due to pressure decline of the residual oil left in the sand. Experience has shown that if an oil reservoir having no natural water drive is produced until all pressure is dissipated without replacing any of the produced fluids with injected fluids, the fraction of in-place oil recovered may be in the range of 20-25 per cent. Complete flushing of the same sand by water may result in raising the recovery of in-place oil to as much as 50-75 per cent. Therefore, it is not unusual for a water injection project to increase oil recovery two-fold, and there are instances where it may be increased three-fold.

The increase in recovery that is experienced by avoiding shrinkage can be explained by considering that oil under high pressure with its dissolved gas may occur somewhere in the range of one and one-half times the volume it would occupy at atmospheric pressure. The sand texture in a given reservoir will determine the percentage of residual oil left after application of a given recovery mechanism, such as gas drive or water drive. In the case of a water drive, the residual oil after complete flushing by water in a given sand would be 25 per cent of the original in-place oil. This would mean that from a segment of zone originally containing 100 bbl of oil, 75 bbl of oil would be recovered and 25 bbl of oil would remain in the sand unrecoverable.

In examining the character of the remaining oil under two sets of conditions assume for the first condition that pressure was completely dissipated during the production process and was at atmospheric level at the end of the production period. In this case, the 25 bbl of oil remaining would represent 25 full surface bbl of crude oil. In the other instance, assume that pressure had been maintained by a natural water drive or by a fluid injection program. Under these conditions, the 25 bbl of remaining oil would be oil with its dissolved gas and in an unshrunk condition. For our example, one and one-half bbl of the unshrunk oil would represent only one bbl of salable tank crude oil. Therefore, by avoiding shrinkage alone, the amount of oil left in the sand has been reduced from 25 to 25/1.5, or $16\frac{2}{3}$ bbl. In other words, the recovery has been increased from 75 per cent of the stock tank oil in-place to $83\frac{1}{3}$ per cent of the stock tank oil in-place merely by maintaining pressure with the same recovery mechanism, *i.e.*, water displacement.

It was stated above that water-injection pressure maintenance would permit more economical operation of wells. It is easily understandable that an oil well can be operated more cheaply when flowing than when operating on artificial lift. It is also evident that when a well is on artificial lift, it can be operated with less expenditure of energy and less mechanical difficulty when the fluid level is high. Therefore, since maintenance of reservoir pressure results in a prolongation of flowing life and also results in high operating fluid levels, the practical result is that a given amount of oil can be produced from such wells at lower cost.

There is also an economic saving that can be realized by injecting water during the primary stage of production rather than by producing all of the oil obtainable by natural forces and then following this program by water flooding after natural pressure is depleted. As a result, several years of well operating expenses may be saved.

PATTERN WATER-FLOODING

"Pattern water-flooding" is used to denote programs whereby additional oil is recovered from reservoirs following depletion of the natural reservoir energy. In such an instance, the field has been essentially exhausted, or has reached its economic

limit if natural forces alone are to be used for displacement of the oil from the sand.

In a program of this type, the wells to be used for water injection are interspersed between producing wells. The injection of water into the alternate wells forces oil into the well bores of adjoining producers that would otherwise remain in the sand unrecovered.

As has already been indicated, in a field without a natural water drive, pattern water-flooding may be only second best when compared to water-injection pressure-maintenance. A logical question then is: "Why water-flood? Why not always begin injection of water during the primary stage of production in order to secure the secondary oil concurrently with the primary oil and in order to more economically operate wells with longer flowing life and higher fluid levels?" This question can be answered by citing several circumstances that often exist in connection with the operation of a field.

1. An extended period of primary production is usually necessary before it can be determined whether or not a field has a natural water drive.

2. In the minds of many operators there are strong doubts with regard to the amount of additional recovery that can be obtained by water injection. If the additional oil recovered by water injection were obtained concurrently with the primary oil, the two batches of oil would be commingled and undistinguishable from each other, making it more difficult to prove how much additional oil is obtained by spending the additional money for water injection. If on the other hand, the primary oil is exhausted and then a pattern water-flood instituted, the increased oil is more easily recognizable and the project can be more definitely justified. At present, a large number of operators recognize the tried and proven benefits of water injection, and more and more projects are being developed to begin water injection operations during the primary stage of production, thus permitting more economical recovery of a maximum quantity of oil.

3. Often times, the realization of the more desirable pressure maintenance program is prevented merely by the vagaries of human nature. Oil men are characteristically rugged individualists. A water injection project usually requires agreement on a large number of points with adjoining operators in the same field. Since opinions will differ on various points, final agreement invariably means that at least one of the operators must change, or compromise, his opinion to agree with that of the others interested in the project. Failure or unwillingness to reach agreement by a change or compromise of opinion, often prevents the consummation of a project even though all parties involved may realize the possible economic benefit to be derived. After depletion of the primary oil, interested operators are usually more willing to "give and take" in order to reach an agreement since they all recognize under such conditions that it is a "last resort" situation.

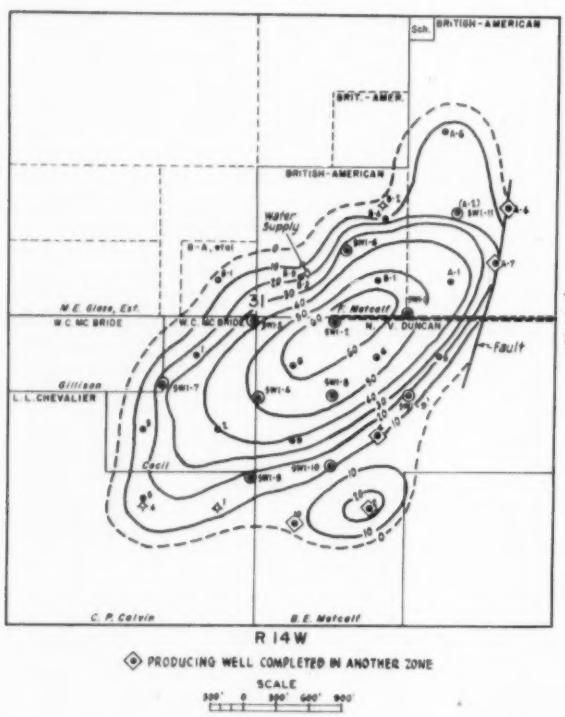

FIG. 1—COOPERATIVE WATER FLOOD, ISOPACH MAP, PENNSYLVANIAN NO. 7 SAND, NORTH CALVIN POOL, WHITE COUNTY, ILL.

COOPERATIVE AND UNITIZED PROJECTS

The ownership of acreage in an oil field is nearly always in the hands of several royalty owners and several operators with intervening property lines marking the boundary between separately owned tracts. For proper conduct of a fluid injection project, the field must either be operated cooperatively or must be unitized.

A cooperative project is developed and operated in such a way that each operator involved retains the title and operation of his own tract, but agrees to develop and operate such tract in accordance with an agreed plan. Likewise, separate royalty ownership requires that separate tracts with the same operator, must be operated and accounted for separately in order to protect the interests of the separate royalty owners.

A unitized project involves a combination of two or more separately owned tracts of land in such a way as to permit development and operation as a single tract with all owners owning a percentage interest in the production therefrom rather than from any one or more wells located on any specific portion of the group of unitized tracts.

By even cursory examination, it is evident that unitization is advantageous over cooperative operation because the diversity of ownership is erased, property lines are wiped out and the entire reservoir can be operated as if it were one lease without regard to possible drainage across property lines.

Rather than describe in greater detail these two types of operation, it appears that a better approach will consist of relating the features and problems encountered in the development and operation of two illustrative projects, one of which is cooperative, the other of which is unitized.

THE NORTH CALVIN PATTERN WATER-FLOOD — AN EXAMPLE OF COOPERATIVE OPERATION

The Pennsylvania No. 7 sand reservoir in the North Calvin Pool, White County, Illinois, covers an area of about 200 acres with an average productive thickness of approximately 29 ft. As will be seen from Fig. 1, the sand thickness varies from 0 to approximately 60 ft.

The oil reservoir is a sand lense with the limits of production defined by a pinch-out of permeable sand in all directions except to the east. The sand lense is truncated on the east

by a normal fault with approximately north-south strike. Production of the field prior to commencement of water-flooding could not be accurately determined because oil from the Pennsylvania No. 7 sand was commingled in tank batteries with oil produced in other zones.

It is estimated, however, that approximately 260,000 bbl of oil was produced from the sand prior to commencement of water injection in 1949. It is interesting to note that at the present time in the relatively early stage of water-flooding, about 365,000 bbl have already been produced since water-flooding commenced.

This project has been developed and operated on a cooperative basis. Flooding was initiated by British-American on a pilot basis in early 1949 by injecting water into the Metcalf "A" No. 2 well, now designated as SWI-11. After approximately six months of injection, it became evident that beneficial response was being obtained, and the three interested operators became interested in developing a full-scale project. As a result, an engineering consulting firm was engaged to study the reservoir to recommend procedure by which a full scale water-flood project could be developed.

Since each company preferred to retain operation of its individual leases, it was agreed that the project should be cooperative rather than unitized. An agreement was then worked out whereby a common water injection plant and jointly-owned water-supply and injection-line system would be installed.

It was agreed that British-American would be the operator of the plant and system and that investment cost would be divided on the basis of estimated oil reserves underlying the property of each of the three interested operators, while monthly operating cost would be divided on the basis of monthly oil production from the Pennsylvania No. 7 sand by each operator.

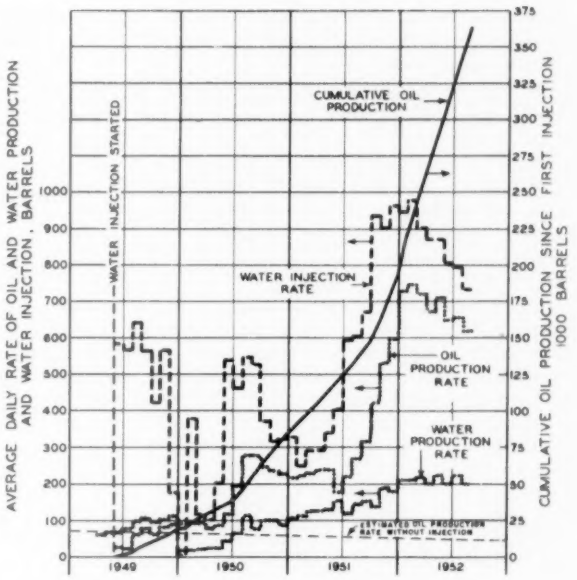

FIG. 3 — RESERVOIR PERFORMANCE, PENNSYLVANIAN NO. 7 SAND, NORTH CALVIN AREA.

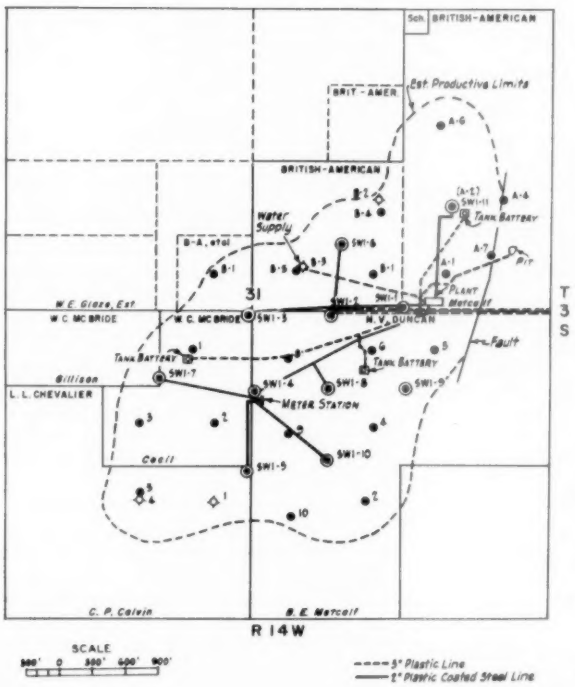

FIG. 2 — INJECTION AND GATHERING LINES, NORTH CALVIN POOL, WHITE COUNTY, ILL.

It was agreed that the injection wells should be drilled along the boundary between separately owned leases to prevent migration of oil from one lease to another and that the cost of each such well would be divided in propertion to the area affected by the injection water from such well.

According to this principle, the cost of injection wells was divided as follows:

1. SWI-1 and SWI-2 — 50 per cent British-American, 50 per cent N. V. Duncan.

2. SWI-3 — 33⅓ per cent British American. (Around the corner on which SWI-3 is drilled, British-American owns the Frank Metcalf lease to the northeast, N. V. Duncan owns the Ben Metcalf lease to the southeast, W. C. McBride owns the Cecil lease to the southwest and each of the three operators owns a one-third interest in the Glaze lease to the northwest. This explains the equal three-way division of interest in this corner well.).

3. SWI-4 and SWI-5 — 50 per cent N. V. Duncan and 50 per cent W. C. McBride.

The consulting firm which prepared the original engineering study on the project has also continued to serve the three operators as technical advisor on reservoir engineering and specialized water-flooding techniques. The consultant is furnished basic factual data concerning water injection, oil production, test information, etc., from which an analytical report is prepared each month. This report contains conclusions and recommendations regarding technical phases of the project.

The plant, water injection lines, and produced-water gathering system were installed as indicated by the map of Fig. 2. Water is injected through internally plastic-coated steel line, while produced water is returned from the tank batteries to the injection plant through plastic line. The injection water in this project is predominantly water produced with oil from

the Pennsylvania No. 7 sand and the Tar Springs sand. This water supply, however, is augmented by fresh water from a shallow supply well.

In Fig. 3 is indicated the performance of the Pennsylvania No. 7 sand reservoir since water injection started about mid-year of 1949.

Peak oil production rate of about 740 B/D was reached in February, 1952. At present, the production rate is slightly above 600 B/D. At the time water-flooding was commenced, the production rate was approximately 50 B/D. Present cumulative oil production since commencement of injection is about 365,000 bbl.

Based on estimated primary oil produced from this sand, about one and one-half times as much oil has been recovered by water-flooding as was recovered during the entire primary stage. It is evident, of course, that a large quantity of additional oil will yet be produced before the end of this operation.

THE PAYTON POOL WATER-FLOOD PROJECT — AN EXAMPLE OF UNITIZED OPERATION

The Payton Pool is located in Ward and Pecos Counties, Texas, about 20 miles south of Monahans on the Pecos River.

Production is from the Yates sand at approximately 2,000 ft. Primary development and production began in 1937. As finally developed, the field covers approximately 2,500 acres.

A water-flood was commenced by Luce and Ice on their Blair and Brictson leases in 1950. They have continued to operate a flood on a profitable basis and are now producing water-flood oil at the rate of about 500 B/D.

Actually, the Luce and Ice flood served as a pilot to prove to the other operators of the field that water-flooding would be successful in this reservoir. An engineering firm was employed by the operators other than Luce and Ice for the purpose of preparing a report on the economic advisability and organizational procedure for water-flooding.

Although it was at first thought that the flood could be operated cooperatively, it was finally decided that it would be a definite advantage to unitize the leases, exclusive of Luce and Ice properties. Consequently, the unit, comprising 2,157 acres, was proposed and necessary agreements were signed by all operators except the Pollard and Davis interests. Pollard and Davis participated in initial efforts to form the project but later withdrew, stating that they preferred to operate their properties independently in cooperation with the unit.

Participation was allotted on the basis of one-third number of wells, one-third cumulative primary recovery, and one-third acre-feet of pay sand. After engineering study, it was determined that these factors would be proportional to the oil recoverable from the tracts by secondary recovery operations.

The unit became effective Nov. 1, 1951. British-American was chosen as unit operator. At this time, 98 per cent of all royalty interests in the entire unit had signed. It is expected that 100 per cent of the royalty interests will be signed in the near future.

Fig. 4 is an indication of reservoir performance since beginning of injection. Actually, it is too early to expect significant results from this project since most of the water injected to date has been into wells located along the boundary line between the unit and Luce and Ice properties. It is only during the last two months that closed five-spots have been in operation. It is significant to note, however, that oil production has increased from approximately 180 B/D to approximately 280 B/D within the last three months shown on the curve.

Based upon performance of the adjoining flood operated by Luce and Ice, it is expected that oil production will climb to considerably higher levels after more water is injected into presently completed injection wells and into future wells yet to be drilled.

It is planned that plant capacity will be increased to as high as 30,000 B/D and that this plant capacity will be used to progressively expand the project by flooding out segments of the reservoir and then moving on to new segments.

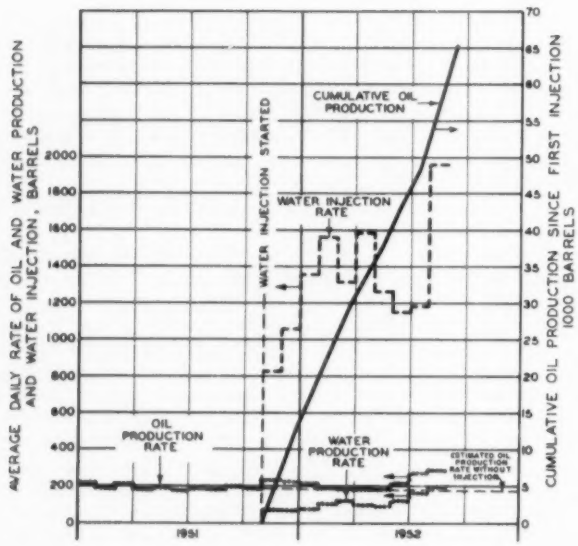
AVERAGE DAILY RATE OF OIL AND WATER PRODUCTION AND WATER INJECTION, BARRELS
CUMULATIVE OIL PRODUCTION SINCE FIRST INJECTION 1000 BARRELS
CUMULATIVE OIL PRODUCTION
WATER INJECTION RATE
WATER INJECTION STARTED
OIL PRODUCTION RATE
WATER PRODUCTION RATE
ESTIMATED OIL PRODUCTION RATE WITHOUT INJECTION
1951
1952

FIG. 4 — RESERVOIR PERFORMANCE, PAYTON POOL YATES SAND UNIT.

WATER INJECTION AT STEAMBOAT BUTTE — AN EXAMPLE OF PRIMARY PRESSURE MAINTENANCE

The Tensleep sand reservoir in the North Steamboat Butte Field of Fremont County, Wyoming, has a reasonably active water drive at lower rates of oil withdrawal. It has been determined, however, that with the oil demand that will exist after completion of the Platte Pipeline, the resultant pressure decline will be excessive if dependent only on the natural water drive for pressure maintenance.

It has therefore been concluded that it will be economically feasible to inject water into the lower part of the Tensleep below the oil-water contact of this field as a means of maintaining high fluid levels at higher rates of withdrawal.

The high fluid level will make possible more economical operation and the more effective displacement by injected water will probably increase ultimate recovery by a significant amount. A water supply well has been drilled into the gravel bed near Wind River. An eight-in. supply line is being laid from this well to the plant location about four miles to the north. Injection lines are being installed from the plant location to the Tribal "V" No. 1, "R" No. 1 and "C" No. 6 wells.

Plant construction will commence as soon as necessary equipment is delivered. Water treatment in the plant will consist

Continued on Page 6, Section 2

Water Flooding in Greenwood County, Kansas

Water flooding was authorized by the State of Kansas in 1935 and the first operation was effected the same year. Here is a report on secondary recovery in Kansas from 1935 to date.

INTRODUCTION

Oil has been produced in Greenwood County, Kansas, for almost 50 years, the discovery well being drilled in 1905 near Toronto. Discovery of Mississippian limestone production was made in the Virgil Field in 1916, and the first production from a Bartlesville "shoestring sand" was obtained in 1917 in the Sallyards Field. Additional Bartlesville production was obtained in the Teeter Field in 1921, and in the Browning, Burkett and Seeley fields in 1922. In 1923, the Aagard Field was discovered and the development of the "Golden Lanes" of the Bartlesville sand stringers progressed at a rapid rate in the middle 1920's.

The Bartlesville "shoestring sands" were found to occur in four trends of sandstone lenses that were deposited in the Cherokee shale of Pennsylvanian age. These trends were established as off-shore bars on two separate shore lines by N. Wood Bass of the State Geological Survey of Kansas. The Teeter and Quincy trends were deposited on one shore line and the Sallyards and Lamont trends were deposited on another. Bass also determined that the sandstone lenses of the Teeter-Quincy trends were deposited prior to those of the Sallyards-Lamont trends. Two of the trends intersect at the Seeley-Wick Field where a difference of approximately 50 ft was found in the depth of the bases of the lenses.

Gas repressuring was initiated in the Bartlesville sand in 1935, and repressuring operations have been conducted in the Browning, Burkett, DeMalorie-Sowders, Madison, Scott, Teeter and Thrall-Aagard fields. However, most of these projects, although generally successful, have been discontinued in favor of water flooding.

The Tonganoxie sand in the Douglas group, commonly known as the "Big Water" sand or simply the "Douglas" sand, occurs throughout most of Greenwood County at depths from 800 to 1,200 ft. As the production from the solution-gas Bartlesville reservoirs began to decline, poorer wells were plugged and abandoned. The plugging practices observed at the time seldom provided effective isolation of the Bartlesville sand from the upper water sand, and operators were quick to observe increases in production from wells in the vicinity of plugged wells. However, water flooding was not authorized by the Kansas Corporation Commission until 1935, and the York State DeMalorie "C" lease became the first legal water flood project in the state in the same year. This flood is still in progress and is now operated by Phillips Petroleum Co.

Many of the water-flood projects in Greenwood County have used the Douglas water for flooding. However, variations in the thickness of the water sand in some areas, and the depletion of the water supply itself in other areas has led to the use of water from the Arbuckle zone and surface water in many of the newer projects. Both "open" and "closed" water systems are used with the Douglas water, while "open" systems are generally used with either Arbuckle or surface water.

It is estimated that more than 178 million bbl of oil had been produced up to July 1, 1952, of which more than 24.5 million bbl had been recovered by water flooding. The recovery of these 24.5 million bbl has required the injection of 211 million bbl of water. The average water-flood recovery to date slightly exceeds 2,900 bbl per developed acre. Several projects have already recovered more than 6,000 bbl per acre. If an average water flood recovery of 5,000 bbl per acre is assumed from an ultimate area of 20,000 acres, a total water flood recovery of 100 million bbl is indicated.

Last October, the Kansas Section of AIME decided to take a look at water flooding operations in Greenwood County, Kansas. Headed by Chairman L. W. Holsapple, the group of engineers visited three company operations. Here are some of the developments they found in the area.

SUNRAY OIL CORP. FANKHAUSER UNIT WATER FLOOD

The Sunray Oil Corp. Fankhauser Unit Water Flood is located in Section 4, T22S, R12E, Fankhauser Field, Greenwood County, about four miles northeast of Madison, Kans. It is a fully electrified project, incorporating a number of features permitting ease of operation and high operating efficiency.

The development is on a 574-acre tract, originally comprising four leases, in which royalty interests were consolidated by unitization agreement; all working interest is owned by the operator. Production is from the Bartlesville sand at 1,900 ft and was initially developed during the years 1926 and 1927 by the drilling of 33 producing wells, 10 of which were plugged prior to secondary recovery development.

Combined production from the 23 active wells averaged 34 B/D during the 12-month period preceding water injection, which was begun in February, 1949. Progressive water flood development resulted in sharp production increases, the rate averaging 1,797 B/D in July, 1950, which was the peak rate of production for the flood.

Development

Input wells were drilled on a five-spot pattern with 10-acre density. In the pilot project, a total of nine injection wells and two water supply wells were drilled. The indicated success of the pilot flood resulted in an extension development, completed

in November, 1949, in which nine additional input wells, one water supply, and two oil wells were drilled. Four more input wells and one supply well were completed in April, 1950, and three wells were completed in January, 1951, making a total of 22 injection, four water supply and 25 oil wells. Two input wells and one oil well along the west lease line have since been plugged and abandoned, and one water supply well has been shut down.

Injection System and Well Equipment

Water meters and regulating valves, necessary to control injection rates, are located at two central manifolds, from which pipe lines radiate to each input well. Cement-lined pipe is used in the water system, and all lines are buried.

Injection wells were drilled with rotary tools and cased with 4½-in. pipe cemented at the top of the producing sand. Rotary cores were taken in the Bartlesville sand and the cores analyzed. Cable tools were used to drill the cement plug in the casing, clean the sand face, and to plug back in cases where shale sections were cut below the sand body, as a precaution against possible water channelling through fractures or bedding planes in the shale. The wells were not shot.

Water Supply

Supply wells are completed in the Douglas sand, a salt-water sand about 100 ft thick, at a depth of approximately 800 ft. The water is ideal for the flood operations because its chemical analysis is similar to that of the interstitial water in the Bartlesville sand.

Filter Plant

A water filtering and pressure plant was constructed and placed in operation in December, 1949. The facilities were designed to maintain a closed system.

Return water is collected from the free-water knockouts and treaters in a 750-bbl receiving tank, then pumped through pressure-type sand filters into a 1,500-bbl clear-water storage tank. Water from the supply wells is pumped directly in to this tank because this water is virtually free of solids and does not require filtering. Two horizontal triplex plunger pumps, driven by 60 hp motors, pump water from storage into the injection system.

Automatic Controls

Control equipment is provided to maintain predetermined operating levels in the clear-water storage tank, by automatically starting and stopping each water supply well when certain selected levels are reached in the storage tank. In addition, other automatic devices are installed which make the plant self-protecting and permit unattended operation, except that required for lubrication pumps and backwashing filters.

Reservoir Data and Recoveries

Average net thickness of the Bartlesville oil sand in the flood project is approximately 24.2 ft. Porosity averages 20 per cent and permeability 78 md. Primary recovery totaled 1,307,000 bbl from date of initial production in 1926 to date water injection was started. The secondary recovery operation accounted for 1,166,300 bbl cumulative production through June, 1952. During this period 5,248,300 bbl of water were injected, of which 2,554,500 bbl were produced with the oil and reinjected into the formation. Return water production averaged about 4,200 B/D during June, 1952.

CITIES SERVICE OIL CO.
MADISON BLOCK WATER FLOOD

The Madison Block takes in 11 leases which has a total of 1,440 acres of which 1,130 acres have water flood possibilities. At the present time the block has 42 producing oil wells, 31 water input wells and three water supply wells.

The pool was initially developed by Cities Service in 1923. Gas repressuring was commenced on the Block in 1931. In October, 1948, the block was partially converted to a water flood project by converting seven oil wells to water input on a 20 acre five-spot pattern. The initial project obtained the water supply from three Douglas sand wells. As the flood progressed the water supply was augmented by water taken directly from the Verdigris river. The gas repressuring was discontinued in February, 1952. At the present time the water flood project is approximately two-thirds developed.

The filter plant system is designed so that it will ultimately have a capacity of 15,000 B/D including all return water expected. The water treating plant is located so that water to be produced with the oil will flow by gravity to the central filter plant. Produced water and fresh water are mixed, treated and filtered for injection into the sand. The plant consists of two 1,600 bbl treating and settling tanks, eight gravity type wood filters and three 5,000 B/D capacity triplex pumps. The water is treated with alum fed into the incoming water by an Omega feeder.

STATISTICAL INFORMATION

Oil produced to Oct. 1, 1948	2,839,441 bbl
Estimated increase due to gas repressuring	1,477,959
Date of first water input	October, 1948
Number input wells, July, 1952	31
Daily water input, B/D	8,419
Daily production of oil before waterflood	200
Daily production of oil, July, 1952	580
Accumulative increased oil due to waterflood	197,216
Sand thickness, average	29

PHILLIPS PETROLEUM CO.
BEAL UNIT WATER FLOOD

Phillips Petroleum Co.'s Beal Unit Water Flood consists of seven leases totaling 1,040 acres in Sections 21, 22, 27 and 28 in T23S, R11E, Greenwood County, Kansas. At present 153 acres are being flooded. Development now in progress will place 220 additional acres under flood. Remaining potential water flood acreage will then amount to 107 acres. All development is on the basis of 10-acre spacing for like wells.

Production on the Beal Unit is from the Bartlesville Sand in the Seeley-Wick Pool of the Quincy trend. Average depth of the Bartlesville Sand on the Beal Unit is 1,963 ft. Porosity averages 17.2 per cent and permeability averages 9.2 md.

Primary development of the leases took place in 1929-31. Production from the 545 primary acres amounted to 4,200,000 gross bbl or about 7,700 bbl per acre.

Initial water flooding on the Beal Unit began in July, 1950, with water being injected into four wells in a 40-acre pilot flood. The initial injection rate was 1,352 bbl of water per day and oil production amounted to 95 B/D. The first increase in oil production occurred in April, 1952, when production for the unit was 114 B/D. In February, 1952, injection was commenced into 12 new input wells, thus increasing the developed acreage to 153.

All of the input wells except one converted well were drilled since water flooding commenced and were completed with 4½-in. casing cemented to the surface. The inputs were not

Continued on Page 9, Section 2

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SUMMARY, RESULTS IN THE FIELD, AND CONCLUSIONS

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1953 Petroleum Branch Fall Meeting To Be Held in Dallas, Oct. 18-21

The 1953 Fall Meeting of the Petroleum Branch, AIME, will be held in Dallas, geographical center of petroleum industry activity in the Southwest. Located midway between the great oil fields of West Texas and the extensive oil sites of Louisiana and the Upper Gulf Coast, Dallas is expected to draw upward of 1,200 petroleum engineers and petroleum geologists to the meeting to be held Oct. 18-21.

The North Texas Section of the AIME will act as host section and will conduct all functions. John H. Murrell of DeGolyer and MacNaughton will be general chairman for the meeting. Other committee chairmen are Raoul Bethancourt of Sun Oil Co., arrangements; Kenneth W. Robbins of Otis Pressure Control, registration; Ruford F. Madera of Republic Natural Gas Co., hotels; R. J. Bradley of San Juan Oil Co., finance; John D. Wisenbaker of Core Laboratories, entertainment; and Brad Mills of the American Association of Oilwell Drilling Contractors, publicity.

E. R. Brownscombe of the Atlantic Refining Co. laboratories, chairman of the North Texas Section, will aid in coordinating the work of all committees. William H. Justice of the La Gloria Corp. is chairman of the Technology Committee which will gather the papers to be presented at the meeting.

Approximately 35 technical and economic papers covering the exploration, drilling and production phases of the oil and gas industry will be given by outstanding research and field engineers.

All technical sessions will be held in the Adolphus and Baker Hotels. Both hotels are located at the intersection of Akard and Commerce streets and are easily accessible to each other. A tentative schedule of events, subject to change, follows:

Sunday, Oct. 18—Petroleum Branch Executive Committee meeting and advance registration.

Monday, Oct. 19—Registration and technical session in the morning and afternoon.

Monday noon, Oct. 19—Welcoming Luncheon with an outstanding speaker.

Tuesday, Oct. 20 — Technical sessions in morning and afternoon.

Tuesday night, Oct. 20 — Annual Branch Banquet and Dance.

Wednesday, Oct. 21 — Technical sessions in morning and afternoon.

It is possible that some field trips will be arranged. Although none has been firmed up at this time, field trips to the many petroleum industry plants, research centers and headquarters buildings in and around Dallas would be more than worth while.

Located in the heart of downtown Dallas are the towering headquarters buildings of the Magnolia Petroleum Co., the Atlantic Refining Co., the Continental Oil Co., the Sun Oil Co. and others. Magnolia and Atlantic also have elaborate research laboratories within easy reach of downtown Dallas. ★ ★ ★

E. R. BROWNSCOMBE

JOHN H. MURRELL

WILLIAM H. JUSTICE

Technical Note 152—

COMMENTS ON CAPILLARY EQUILIBRIUM

J. JONES-PARRA, VENEZUELAN MINISTRY OF MINES AND HYDROCARBONS AND THE PENNSYLVANIA STATE COLLEGE, STATE COLLEGE, PA., JUNIOR MEMBER AIME

In previous Technical Notes, W. R. Rose[1] and W. Purcell[2] have discussed the capillary pressure data presented by Welge.[3] Welge obtained capillary pressure curves of the imbibition type in which it was necessary to apply to the apparent wetting phase a greater pressure than that of the non-wetting phase to complete the cycle and reduce the non-wetting phase saturation to low values. Rose suggests in his Note that conditions of equilibrium could not have prevailed, since the non-wetting phase pressure must always be the greater. Purcell in his Note, proceeds to postulate a pore system consisting of a series of "holes in a doughnut," in which he contends that under equilibrium conditions it is necessary to resort to negative capillary pressures before significant wetting phase displacement can take place. There is a remarkable similarity between the shape of the capillary pressure curve calculated by Purcell and those measured by Welge.

It is the purpose of this Note to show that, because Purcell neglected to account for the behavior of the residual wetting phase saturation, his system was not in equilibrium during imbibition; and, furthermore, that if his system had been in equilibrium, negative capillary pressures would not have been possible.

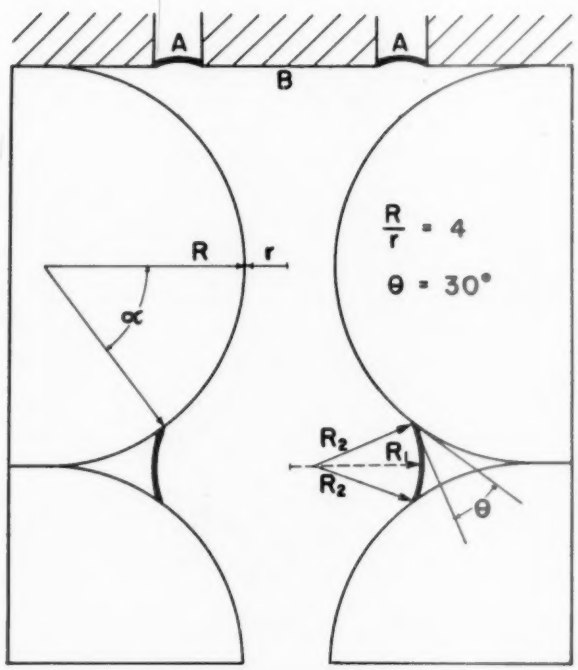


FIG. 1 — DIAGRAM OF PORE SYSTEM.

In Purcell's pore system, the residual wetting phase will form pendular rings at the interstitial spaces existing somewhere within the system, for example, such as those spaces between "doughnuts" as shown in Fig. 1. The true capillary pressure is that across the pendular ring interface, and for the system to be in equilibrium the pressure drop across all interfaces must be the same, including that across the interface in the tight pores A of diaphragm B (Fig. 1). As the pressure across the cell is reduced, the advancing interface will move into the pore from the diaphragm, but at each pressure, the curvature of the pendular rings must be the same as that of the advancing interface if equilibrium is to prevail. Since equilibrium conditions are the basis for the entire argument, it follows that pendular rings must grow as wetting phase enters the pore, that is, as the pressure across the cell is lowered. In Purcell's calculated curve, the residual wetting phase saturation remains constant as the capillary pressure decreases. Thus, his curve does not represent an equilibrium process.

By defining the principal radii of curvature (R_1 and R_2, Fig. 1) in terms of the geometry of the system, it is possible to obtain the position of the pendular ring contact at each pressure in terms of the angle α, in the same manner as obtained by Purcell for the advancing contact. This relationship is:

$$\frac{P_c R}{2\sigma} = \frac{1}{2}\left\{\frac{1}{\frac{2\sin^2\left(\frac{90-\alpha}{2}\right)}{\sin(\alpha-\theta)}[1-\cos(\alpha-\theta)]+1-\cos\alpha+\frac{r}{R}} + \frac{\sin(\alpha-\theta}{2\sin^2\left(\frac{90-\alpha}{2}\right)}\right\}$$

In Fig. 2, the dimensionless quantity $P_c r/2\sigma$ from this equation is plotted against α. The equivalent curve calculated by Purcell for the advancing interface contact is plotted on the same figure (dashed curve). Both curves correspond to a contact angle of 30°.

The process of imbibition can best be explained by referring to Figs. 2, 3 and 4. Let it be assumed that the drainage cycle was completed at point A ($\alpha_p = -75°$, $P_c = (2.8)2\sigma/r$, $S_w = .85\%$), and that at this point imbibition starts. As the pressure is decreased along line AB, there will be a corresponding change in α_p and S_w. At B, the pressure will be low enough for the advancing wetting phase to move into the pore, and this contact will be at $\alpha_a = +7°$. At this point the pressure will be $(.9)2\sigma/r$, the wetting phase saturation 2.4 per cent and the pendular contact will be at $\alpha_p = -64°$. The pressure is decreased further until point C is reached. The pressure across the pendular ring interface is asymptotic at the two values of

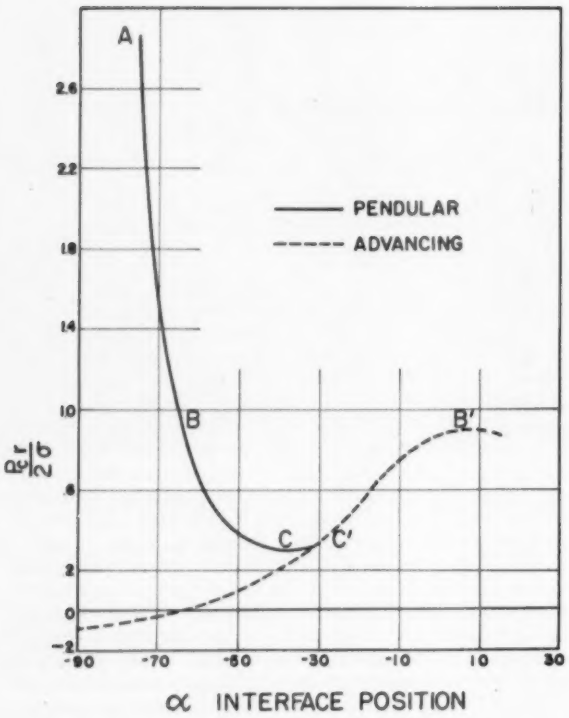


FIG. 2 — POSITION OF INTERFACE — SOLID CONTACT.

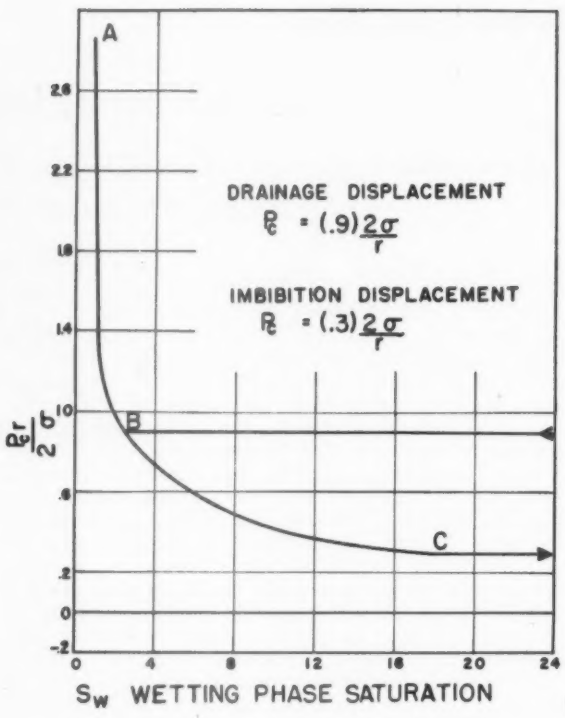


FIG. 3 — CAPILLARY PRESSURE VS WETTING PHASE SATURATION.

α_p for which R_1 and R_2 respectively become zero, hence there is a minimum to the curve at point C. The pressure across the interface cannot be less than $(.3)2\sigma/r$. When this pressure is reached the pendular ring contact will be at $\alpha_p = -38°$ but the advancing contact will be at $\alpha_a = -32°$ (point C'). Regardless of the effect it will have on the pendular ring, as the pressure is decreased further the two contacts will merge, and this will occur in the neighborhood of points C, C' ($P_c = (.3)2\sigma/r$, $S_w = 18$ per cent). Below this pressure the non-wetting phase will be displaced from this and all interior pores.

Hence, as suggested by Rose, the imbibition capillary pressures obtained by Welge (as well as that calculated by Purcell) appear to have but little physical significance. They represent the variation in saturation with pressure difference imposed across the capillary pressure cell, and not variation in saturation with pressure drop across every internal interface.

To obtain at each imposed pressure the absolute equilibrium required if a true imbibition curve is to result, sufficient time must be given for the pendular rings to grow. Consider the process: if at any imposed pressure the pressure drop across the pendular ring interface is not the same as that across the advancing interface, the vapor pressure (or solubility in liquid-liquid systems) over these interfaces will not be equal. Equilibrium will not prevail unless sufficient transfer occurs across the non-wetting phase for the curvature of the pendular ring interface to change until all curvatures in the closed system (the capillary pressure cell) are the same. Thus it is apparent that the rate of equilibrium attainment is dependent upon the rate of diffusion of the wetting phase through the non-wetting phase under the gradient existing between

Continued on Page 9, Section 2

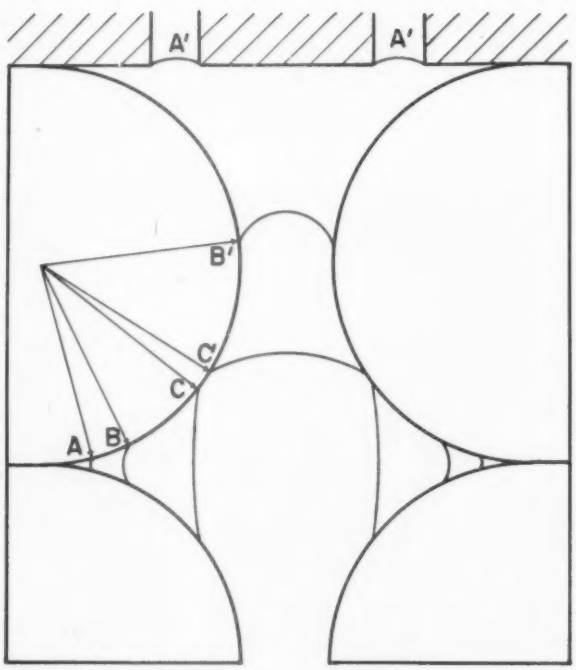
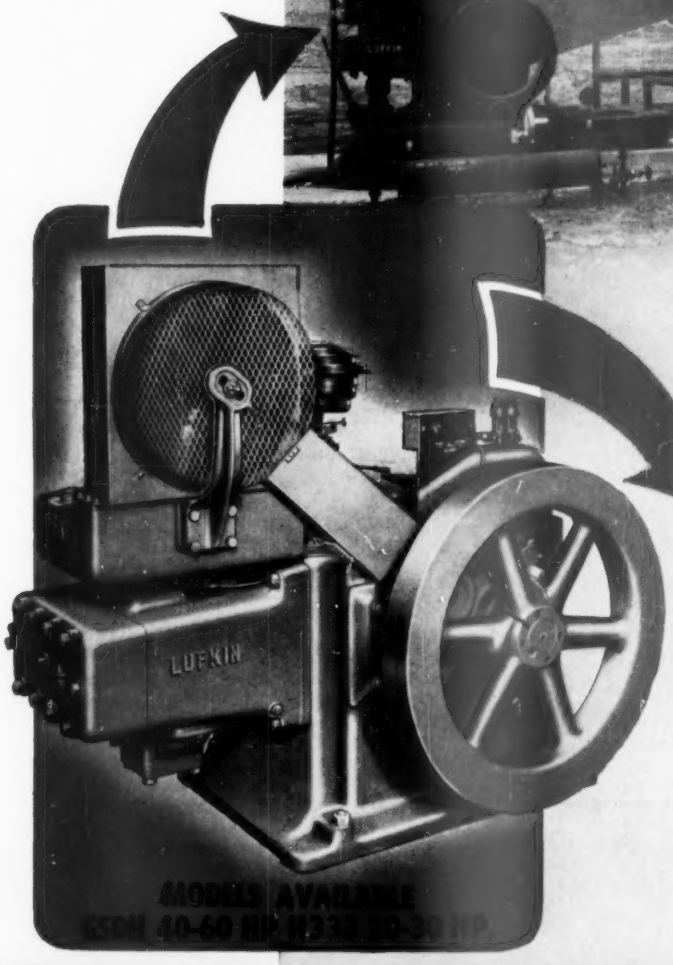


FIG. 4 — ADVANCE OF INTERFACES.

Lufkin ENGINES



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- Full pressure lubrication with oil under pressure forced to all wear points for longer life and trouble-free service.
- Easy starting by hand. Optional: Built in 12-volt electric starting system, or air-gas motor starting requiring only 25# gas pressure.

Lufkin engines can take it, which has been proven in the field over many years of continuous operation. We invite you to write direct or check with your nearest Lufkin representative for information and delivery.

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Lufkin Equipment in CANADA is handled by
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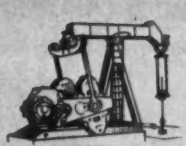
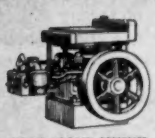
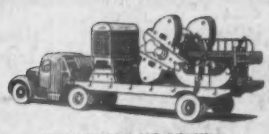

LUFKIN PUMPING UNITS


LUFKIN-COOPER-BESSEMER ENGINES

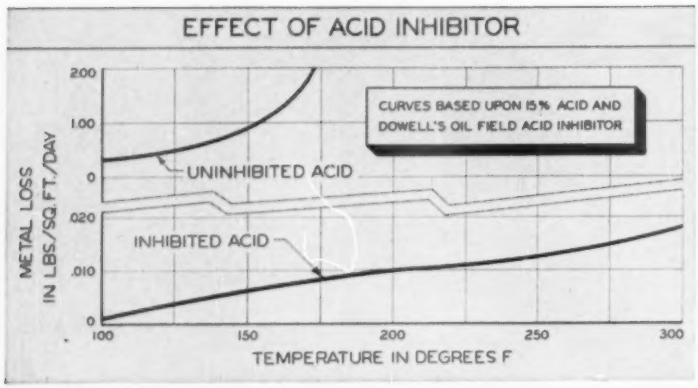

LUFKIN OIL FIELD AND INDUSTRIAL TRUCK TRAILERS

INDUSTRIAL SPEED REDUCERS AND INCREASERS

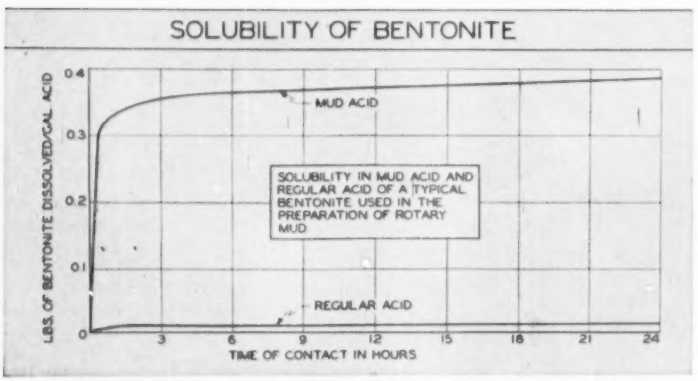
DIVISION LUFKIN FOUNDRY & MACHINE COMPANY INDUSTRIAL, MILL AND AUTOMOTIVE SUPPLIES

MORE FOR YOUR MONEY...

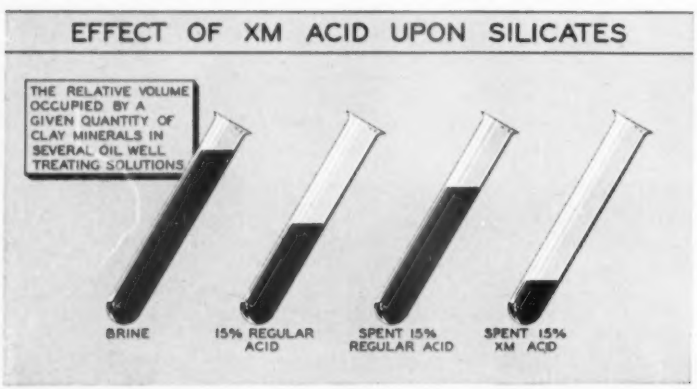
Let Dowell Fit Acidizing to Your Specific Well Problem



Dowell inhibitor permits high-temperature acidizing, and retards the rate of corrosion on well equipment to the point where acid damage is not at all apparent.



Ordinary commercial bentonite, such as is used in the preparation of drilling muds, is many times more soluble in Mud Acid than it is in regular acid.


EFFECT OF XM ACID UPON SILICATES
THE RELATIVE VOLUME OCCUPIED BY A GIVEN QUANTITY OF CLAY MINERALS IN SEVERAL OIL WELL TREATING SOLUTIONS
BRINE
15% REGULAR ACID
SPENT 15% REGULAR ACID
SPENT 15% XM ACID

This drawing illustrates the swelling-control effect of XM Acid on silicates. The same quantity of silicates has been placed in each of four different solutions.

Acid Corrosion? Ask for *Dowell X*—Corrosion of tubing, packers and other well equipment can become especially important in acidizing wells with high bottom hole temperatures. The Dowell inhibitor used in oil well applications reduces metal loss to approximately .01 lb. per sq. ft. per day at temperatures as high as 200°F., with less loss at lower temperatures. Some inhibitors considered highly effective will display corrosion rates at least 10 times greater.

Removal of Mud? Ask for *Dowell Mud Acid*—Dowell Mud Acid is used to remove mud sheaths and to acidize certain dolomite and sand formations. It also provides a superior method of removing mud from critical areas prior to squeeze cementing. Mud Acid is designed to dissolve bentonite and similar silicate materials.

Silicate Swelling? Ask for *Dowell XM Acid*—Certain dolomite and limestone formations contain silicates which can swell during acidizing and actually block formation pores. XM acid is designed to control such swelling. XM acid treatments have shown greater increases in production, less emulsion and easier return of the spent acid.

Faster Acid Action? Ask for *Dowell XX Acid*—This acid contains an intensifier to increase the reaction rate on dolomitic formations. Dowell XX acid is also designed to provide greater solvent action on other formations.

Easier Acid Injection? Ask for *Dowell XF Acid*—This acid contains a chemical to reduce surface tension, thereby increasing the penetrating and wetting abilities of the acid. Addition of the F agent aids in the return of the spent acid and permits treatment of relatively fine pores.

Oil Emulsions? Ask for *Dowell XW Acid*—An agent is added to this acid which helps to prevent the formation of emulsions and aids in the breaking of emulsions that have already been formed.

Remove "Gyp"? Ask for *Dowell XG Acid*—This acid contains a foaming agent which is helpful in removing "gyp" from tubing or the face of pay.

Tracing Agent? Ask for *Dowell XC Acid*—A special agent, used in XC acid, enables engineers to tell spent acid from formation water. Spent XC acid has been found in nearby wells. Migration to other formations higher or lower in the well has also been traced.

Other problems? Dowell uses a wide range of other treating services, chemicals, products and tools, including: Jel X materials, Sandfrac, Heavy Acid, Hot Acid, Securaloy Removal, Blanket, Soap Seal, Jelly Seal, Jelflake®, Temporary Plugging Materials, Temporary Fillers, Paraffin Solvents, Triple Zone Acidizing Tools, Compressors, Bridge Plugs, Jet Guns and Packers.

DOWELL ACIDIZING SERVICE

Wide Range of Dowell Addition Agents and Treating Techniques Permits Fitting Acidizing Service to Your Well

Are you getting the most profitable results possible from your acidizing jobs? Let Dowell fit the treatment to your problem . . . as they did for this operator:

In an area where treatments with regular acid had never given a potential of more than 100 barrels of oil per day, a Dowell engineer recommended using the improved M agent for silicate control. The XM acid treatment resulted in a potential of 300 BOPD!

The key to successful acidizing is in selecting the *right* acid and treating technique for the job. As formations vary, so must the methods in order to get the best results. Dowell offers a wide range of addition agents, tools and techniques designed to make treatments more effective. These have been developed in the field and in Dowell laboratories during more than 20 years of acidizing experience.

When you need acidizing, be sure to get your money's worth. Dowell has the experienced engineers, the specialized equipment and the widest range of formation-tailored treating solutions available.

There's a Dowell office near you . . . call them today.

MORE INFORMATION?

For detailed information on any of the Dowell Services, drop a card to Dept. B-15, Tulsa 1, Oklahoma. Be sure to mention the particular service in which you are interested.

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Acidizing • Jel X* • Electric Pilot • Perfo Jet • Paraffin Solvents • Jelflake®
Bulk Inhibited Acid • Chemical Cleaning for Heat Exchange Equipment

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"First in Oilfield Acidizing . . . Since 1932"

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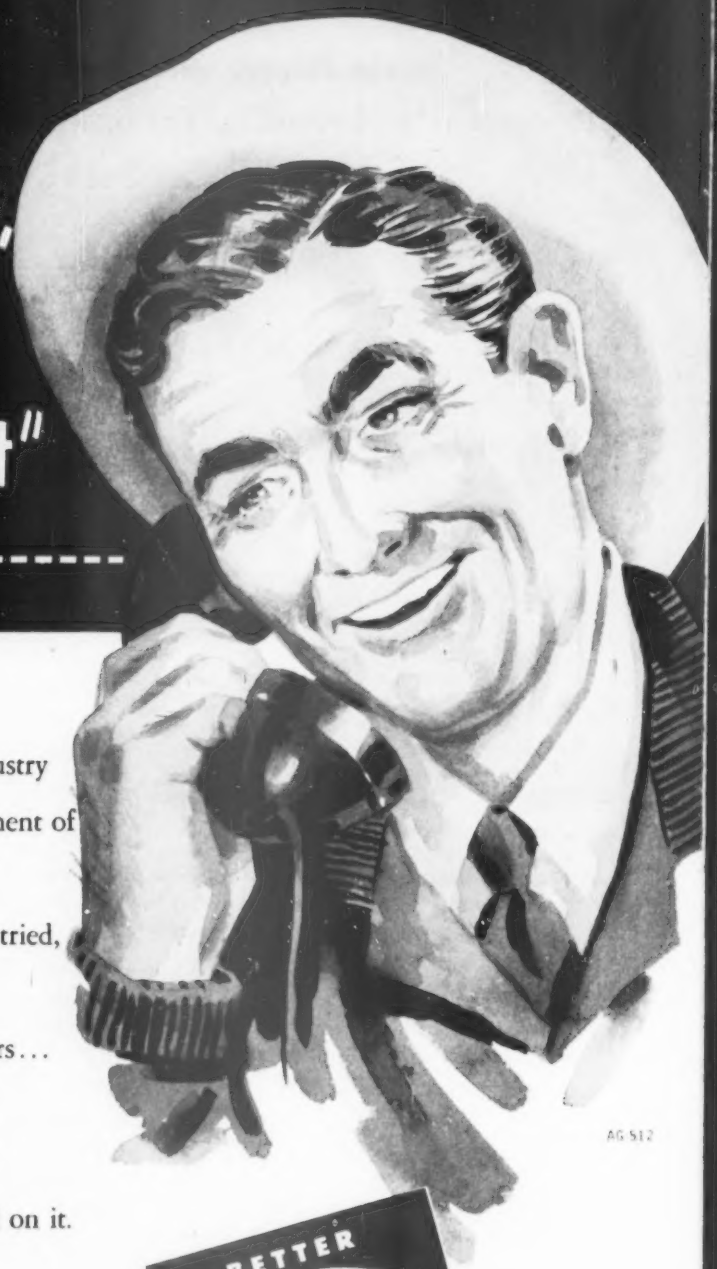
"If Lane-Wells has field-tested it, it's O.K. Go ahead and use it"



Whenever Lane-Wells offers the oil industry a new product, a new service or an improvement of any kind, operators know that they're getting something that's been thoroughly checked, tried, tested and retested beforehand. That's been Lane-Wells rigid policy, all through the years... make sure it's right *first*. And that is one strong reason why operators have confidence that if Lane-Wells says it's right, they can depend on it.

"Not how new, but how good!"

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"FOR DISTINGUISHED ACHIEVEMENT"

Petroleum Geologist Holman Receives Rand Medal

Eugene Holman, president of Standard Oil Co. (N.J.), was to be awarded the Charles F. Rand Memorial Medal at the Annual Meeting in Los Angeles this month.

The citation accompanying the award reads:

"For distinguished contributions to the field of petroleum geology which resulted in the conservation of our nation's sources of liquid energy; for the far-sighted development of oil resources in other parts of the world; for ably administering the affairs of an industrial organization supplying a commodity essential to the strength and well-being of many free peoples; and for his efforts in behalf of greater understanding among men so that our country and others might enjoy greater prosperity and the hopes of lasting peace."

Holman is the ninth recipient of the medal, which is given "for Distinguished Achievement in Mining Administration." In 1949 it was awarded posthumously to Harry Carothers Wiess, who is the only other petroleum industry man to be so honored.

Holman grew up in Monahans, Tex., where, as a boy, he worked in his father's livery stable and feed store. He was graduated with a BS degree from Simmons College, now Hardin-Simmons University, in 1916, and received a master's degree from the University of Texas the following year. Here, through the influence of a geology professor, he was persuaded to become a geologist rather than enter the field of civil engineering, for which he the producing department of Standard Oil Co. (N.J.) as assistant to the vice-president. In his position he became interested in foreign production problems, and subsequently served as president and director of Creole Petroleum Corp. and Lago Petroleum Corp., Venehad been studying.

EUGENE HOLMAN

In 1917 he went to Cuba with an oil exploration party, and subsequently worked in Mexico, Texas and Washington, D. C. During World War I he was an aerial photographer with the Army. In 1919 he joined Humble Oil and Refining Co., working in north central Texas and in Louisiana. He became chief geologist of the company in 1926.

In 1929, Holman was transferred to zuelan affiliates of the company.

He was named a director of Jersey Standard in 1940, and vice-president in 1942. Since 1944, he has been president of the company.

A strong advocate of world cooperation, industrial peace and a minimum of government control of private business, Holman is recognized by business and labor alike as a progressive, international-minded and capable executive. His company has had no major strikes since 1915 and Holman has done much to further good labor-management relations.

The Rand Medal is awarded from a foundation established in 1930 as a memorial to Charles F. Rand, who had been an active member of the Institute. It is one of the four major awards of the AIME, and the medalist is elected by the Board of Directors upon recommendation of a special award committee. Chairman of the Rand Foundation Award Committee is W. E. Wrather. The citation for Holman was prepared by John R. Suman. ★ ★ ★

President's Appointment Of Humphrey Honors AIME

Selection by President Eisenhower of a notable member of the AIME for a cabinet post, as Secretary of the Treasury, is not only a great compliment to George M. Humphrey, but to the AIME, and to the mining engineering profession as well. Humphrey joined the Institute back in 1922, shortly after he had joined the staff of the M. A. Hanna Co. as an attorney. Those who attended the 75th Anniversary Celebration of the AIME at the Waldorf-Astoria in March, 1947, will recall that he was awarded the Charles F. Rand Medal for mining administration at the Annual Banquet.

The AIME has been fortunate in having several of its members serve in cabinet posts during the last generation. Herbert Hoover, of course, who served as Secretary of Commerce from 1921 to 1928, and as President of the United States for the next four years, was our most conspicuous representative. Among his cabinet appointments was Ogden L. Mills as Secretary of the Treasury, who, like Humphrey, was an AIME member. In 1933, President Roosevelt named another AIME member as Secretary of War — George H. Dern, who had been Governor of Utah. And in 1940 Charles Edison was named Secretary of the Navy.

AIME members are not unknown in the halls of Congress and in important diplomatic posts as well.

All have rendered conspicuous service to their country, and should be an inspiration to other members of the profession to aim for the highest rewards of citizenship. ★ ★ ★

ADVANCE AIME MEETING CALENDAR

	1953	1954
AIME Annual Meeting	Feb. 15-19 Statler Hotel Los Angeles	Feb. 14-18 Statler Hotel New York
AIME Fall Meeting	El Paso	
Petroleum Branch Fall Meeting (Mid-Continent)	Oct. 18-21 Baker and Adolphus Hotels, Dallas	San Antonio, Tex.
Regional Meeting, Pacific Petroleum Chapter	Oct. 1-2 Ambassador Hotel Los Angeles	Not determined

Personals

MARSH S. WATSON, JR. has resigned as water flood engineer for Richardson and Bass in the West Texas division and joined the firm of Buckles and Hostetler, oil production consultants, Monahans, Tex. Watson is a petroleum engineering graduate of New Mexico School of Mines, and received a Masters degree from the University of Oklahoma. He has done petroleum engineering work for major companies in Texas, Louisiana, New Mexico, California and South America. For the past three years he has been active in water flood projects in West Texas.

+

R. G. PARKER has been transferred to the central region office of the Continental Oil Co. in Oklahoma City. He had served as chairman of the North Texas Section of AIME during 1952.

+

ALBERT B. STEVENS of the petroleum engineering department, Texas A&M College, has been appointed head of that department effective Feb. 1, 1953. He succeeds Harold Vance. Stevens holds his BS degree in petroleum engineering from the University of California and his MS degree from the University of Southern California. He has been connected with the petroleum engineering profession since 1927 at which time he was employed by the Gypsy Oil Co. in Oklahoma. Prior to joining the staff at A&M he was on the staff of the University of Southern California.

+

JOHN STICK, JR., formerly chief electrical engineer and associated with Lane-Wells Co. since 1937, has been appointed chief geophysical engineer in charge of the company's new geophysical section. During the war, Stick worked on a special war project for the Division of Physical War Research at Duke University. He is a graduate of California Institute of Technology.

J. L. CRITTENDEN has been promoted to supervising petroleum engineer in the West Texas division office of Humble Oil and Refining Co. He previously was district petroleum engineer for the Means district.

+

B. K. BEVILL, formerly district petroleum engineer at Stanton, Tex., for Humble Oil and Refining Co., has been transferred to the Means district in West Texas.

+

L. A. ALLAUD has been appointed technical assistant to the vice-president, operations and general services, for the Houston headquarters of Schlumberger Well Surveying Corp. Allaud is a native of France. He came to the United States in 1936 and went to work for Schlumberger as an engineer in New Iberia, La. He has served as division manager in Wichita and area manager in Tulsa. In 1948 he was transferred to Surenco and served in South America. Since March of 1952 he has been located in Fort Worth serving as assistant to the Northwest Texas area manager.

+

E. P. HAYES, former chief petroleum engineer for The Texas Co., has been appointed chief petroleum engineer of the producing division of the California Texas Oil Co., Ltd. Hayes was graduated from the Case School of Applied Science with a degree in mechanical engineering in 1915. After serving in an aviation unit in France in World War I, he went to Fort Worth, Tex., where in 1925 he became assistant engineer in charge of a helium plant for the Bureau of Mines. When that plant was closed, he went into the potash division of the Bureau. Later, he served in the petroleum division of the Bureau at Bartlesville and Dallas, working in the Oklahoma City and East Texas fields. Hayes became affiliated with The Texas Co. as petroleum engineer in the South Texas division in 1933.

LEWIS H. BOND, JR. was recently elected assistant vice-president and petroleum engineer for the Fort Worth National Bank. Born in Ashport, Tenn., he received a BS degree in petroleum engineering from the University of Oklahoma. During the war he served with the United States Army in the European and Asiatic theaters, and was discharged in 1946, having attained the rank of captain. He was then employed by Stanolind Oil and Gas Co., and became associated with the Fort Worth National Bank's oil loan division as a petroleum engineer on June 15, 1952.

+

HOWARD B. BRADLEY has been released from active duty with the U. S. Navy and is now senior research engineer for the Magnolia Petroleum Co. Field Research Laboratory in Dallas, Tex. For the past 17 months he served as petroleum and gases officer and laboratory officer at the Norfolk Naval Shipyard, Portsmouth, Va.

+

FRED M. SPRINGER has been released from active duty with the Army and has returned to work with Magnolia Pipe Line Co. of Dallas, Tex., as an engineer trainee. At present he is located in Seminole, Tex. He had been in the military service since November, 1950.

+

C. K. SEAMAN, JR., formerly acting district superintendent for Humble Oil and Refining Co., at Wink, Tex., has been transferred to the Stanton district.

+

O. H. BERRY, JR. has joined the Vickers Petroleum Co. of Wichita, Kans., as chief engineer to supervise deep drilling operations. Berry had been associated with the Wilshire Oil Co., and previously had served as division engineer with Standard Oil Co. of Texas. He is a graduate of Texas A&M College. In his new position he will be headquartered in Oklahoma City.

C. R. Hocott is 30th Branch Chairman

The Petroleum Branch, AIME, installed its 30th Chairman this month at the Annual Meeting of the Institute held in Los Angeles' new Statler Hotel. Occupying this coveted position of one of the world's oldest major professional societies is Claude R. Hocott, assistant head of petroleum research for Humble Oil and Refining Co. in Houston, Tex.

The occasion for the brief ceremony was the Petroleum Branch banquet. Paul R. Turnbull of the La Gloria Corp., Corpus Christi, Tex., Branch Chairman during 1952, turned over the gavel of office to Hocott halfway through the evening function.

The new 1953 Branch Chairman joined the AIME in 1939 and has since served in various important posts of the Petroleum Branch. He was chairman of the Papers and Programs Committee (now the Technology Committee) in 1945 and was charged with the responsibility of gathering the important technical papers for the various Branch meetings during that year. In 1946 he was elected Associate Branch Chairman (a position now known as vice-chairman) of the Petroleum Branch and assumed a seat on the Executive Committee.

Recently he authored the comprehensive "Hocott Report" which was submitted to the AIME Board of Directors by the Petroleum Branch. The report dealt with proposed improvements and changes in the Institute administrative procedures.

Chairman Hocott was born in Excelsior, Ark., on Nov. 16, 1909. He attended public schools in Greenwood, Ark., but journeyed to Texas for his formal education. He was graduated from the University of Texas with a degree in chemical engineering in 1933 but returned to receive his MS in 1934 and PhD in 1937. While at the university, he was elected to Tau Beta Pi, Phi Lambda Upsilon and Sigma Xi.

Extracurricular activity at the university led him to meet Edna Rae Gunn of Bronte, Tex., whom he married on June 8, 1937. Today the Hocotts have two daughters, Gail, 9 and Elaine, 12.

CLAUDE R. HOCOTT

Hocott began his professional career with Humble Oil and Refining Co. in June, 1937, as a research engineer in the production research division. By 1942 he had progressed upward to the position of assistant head of production research.

In addition to his activities in the AIME, he is a member of the API Research Advisory Committee. ★ ★ ★

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edited by STUART E. BUCKLEY

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Proposed for Membership, Petroleum Branch

Total AIME membership on Oct. 31, 1952, was 18,333; in addition 1,697 Student Associates were enrolled.

PETROLEUM BRANCH ADMISSIONS COMMITTEE

J. H. Sullivan, Chairman; Thomas S. Bacon, Vice-Chairman; A. E. Caraway, Frank C. Kelton, Thomas E. Morton and F. C. Prutzman.

INSTITUTE ADMISSIONS COMMITTEE

T. D. Jones, Chairman; Thomas G. Moore, Vice-Chairman; Harold S. Bell, F. W. Hanson, R. H. Chadwick, T. W. Nelson, J. H. Scaff, John T. Sherman, A. C. Brinker, Ivan Given, C. A. R. Lambly, G. P. Lutjen, E. A. Prentis and C. Leslie Rice, Jr.

The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

In the following list C/S means change of status; R, reinstatement; M, Member; J, Junior Member; A, Associate Member; S, Student Associate.

ALABAMA

Mobile — Mashburn, Clifford H. (C/S-S-J).
Tuscaloosa — Graham, John Hugh (C/S-S-J).

CALIFORNIA

Bakersfield — Burtchaell, Edward P. (C/S-J-M.)
La Habra — Dykstra, Herman (C/S-J-M).
Long Beach — Hepburn, George Cyrus, Jr. (M); Keegan, Harry Emmett (J); Weeks, Harold Edward (M).
Los Angeles — Mallory, Paul Bradford (C/S-J-M); McKinnon, Murray Campbell (C/S-S-J); Michols, John Henry, Jr. (J); Trobaugh, Allen Kieffer (R,C/S-S-M).
Manhattan Beach — Boreta, John (J)
San Francisco — Leake, William Dean (J).
San Gabriel—Casler, Earle Townsend, Jr. (J).

COLORADO

Denver — Marshall, John (M).

ILLINOIS

Bridgeport — Pinner, Felton Robert, Jr. (C/S-S-J).
Salem — Ramsey, Harry James (C/S-S-J).

INDIANA

Evansville — Roe, William Howard (C/S-J-M).

KANSAS

Liberal — Ford, John Daniel (R,C/S-S-J); Oil Hill — Vachal, Barney M. (C/S-S-J).
Russell — Ford, Will D. (M).
Wichita — Davis, Horace Chesterfield (C/S-A-M).

LOUISIANA

Donaldson — Conner, Martin Carriere (J).
Lafayette — Dominy, Kenneth LeRoy (C/S-J-M).
New Orleans — Bailey, John Franklin (M); Garner, Alva Curtis, Jr. (J); Jay, Webb (J).
Venice — Krysuik, Eugene Thomas (C/S-S-J).

MICHIGAN

Wayne — Cushing, James Earl (C/S-S-J).

MISSOURI

Rolla — Taylor, Langdon B. (R,C/S-J-M).

NORTH DAKOTA

Williston — Dallas, Dois Deleware (J).

OKLAHOMA

Bartlesville — Charles, Robert C. (J); Poettmann, Fred Heinz (C/S-J-M).
Chickasha — Comby, Harvey Richard (J).
Cleveland — Johnson, Erd Mullendore (C/S-S-J).
Cushing — Sullaway, Guy Burrell (M).
Keystone — Swift, Virgil Neil (C/S-S-J).
Pawhuska — Barber, R. Curtis (M).
Tulsa — Benway, Rex Bernard (M); Folger, Frank C., Jr. (R,M); McGinnis, Thomas L. (R,M); Vaughn, Carlos R. (M); Whitmore, William Philip (M).

PENNSYLVANIA

Philadelphia — Gottlieb, Benjamin Manuel (M).
Pittsburgh — Redic, John Gabriel (C/S-S-J).

SOUTH DAKOTA

Rapid City — Gilles, Albert P., Jr. (C/S-S-J).

TEXAS

Abilene — Russell, James Edwin (R,M).
Alice — Flournoy, Lucien (A); Hendrix, James Richard (J).
Alvin — Ziegler, Alvin Earl (C/S-S-J).
Arlington — Nelson, Murrell Dixon, Jr. (M).
Beeville — Phillips, William Bryan (C/S-J-M); Syfan, Frank Edwards (A).
Bellaire — Binkley, George W. (J).
Bishop — Case, Edward Morgan, Jr. (C/S-S-J).
Breckenridge — McKinney, Oscar Bryan (J).
Canton — Nixon, Billy Pitt (C/S-S-J).
Conroe — Watson, Ernest Decatur (C/S-S-J).
Corpus Christi — Bates, Robert Emory (M); Burns, L. Robert (A); Crutchfield, John Willard (C/S-J-M); Fowler, Zeke W. (A); Jacobs, Charles Edward (J); Johnston, Dick C. (C/S-S-J); Kitowski, Charles Bernard (A); Logan, Charles Edward (J).
Dallas — Beams, Robert Jess (C/S-J-M); William McClester (J); Clay, Thomas Weldon (A); Crosky, Robert Andrew (C/S-S-J); Dallas, Orlan Lee (R,M); Gill, Eric (J); Lancaster, Gordon Gus (C/S-J-M); Moredock, Shirley Kenneth, Jr. (C/S-S-J); Reneau, Wilbur Eugene, Jr. (J).
Dripping Springs — Garnett, Gene Norwood (C/S-S-J).
Fort Worth — Allen, Roy William (A); Vaughan, Jack Burnett (M); Weymouth, Thomas Rote II (M).
Fredericksburg — Hahn, Harvey Charles (J).
Gladewater — Haas, Joseph Marshall (J).
Houston — Morgan, Bryan E. (C/S-J-M); Poyner, Herbert Flake (R-J); Terry, William Martin (M); Walker, Robert Julian (M); Young, Roy Milton (J).
Katy — Barbour, Russell Clyde, Jr. (J); Langner, Charles Arthur (J).
Kilgore — Durall, Dean Dobkins (C/S-S-J).
Levelland — Hall, Jack Eugene (M).
Lubbock—Lessentine, Ross Henry (C/S-S-J).
Midland — Evans, John Roy (C/S-J-M); Jones, Crandall Davis (M); Ray, Edward Ben (M).
North Cowden — Allen, Warren Irvin (C/S-J-M).
Odessa — Coventon, Edwin Lloyd (J); Rosenkranz, Ronald George (C/S-S-J); Yukl, Edward Theodore (C/S-S-J).
Rio Grande City — Boothe, William Archer (C/S-J-M).
Sherman — Telford, Billy Hugh (C/S-S-J).
Sundown — Meadows, Paul Dwain (J).
Wichita Falls — Beekman, Robert Leon (C/S-S-J); Miller, Buck Joe (C/S-J-M); Williams, James M., Jr. (R,C/S-S-J).

WYOMING

Casper — Conrad, Clarence Frederick (C/S-S-J).
McFadden — Sherwood, Clark Merrill (C/S-S-J).

MEXICO

Mexico, D. F. — Lopez Nieto, Guillermo (A).

VENEZUELA

Maracaibo — Bower, Edward R. (M); McGrath, Patrick Bernard (C/S-J-M). ★ ★ ★

HAVE YOU CHANGED YOUR ADDRESS?

In order that publications and correspondence may reach you promptly, the Petroleum Branch, AIME, should be advised as soon as possible of any change in your address, preferably a month before the change becomes effective. For the AIME directory and for the Personals column of the JOURNAL OF PETROLEUM TECHNOLOGY, additional information is desired. The form below is provided for your convenience, and should be sent to Petroleum Branch, AIME, 800 Fidelity Union Bldg., Dallas 1, Tex.

Name_____ Membership No._____

Old Address_____

New Address_____
for
Publications_____

Title or Position Held_____

Address for
Directory
Listing_____

List below your former title or company position, nature of your new position, or other information of interest to your associates for publication in the JOURNAL OF PETROLEUM TECHNOLOGY.

Doherty Memorial Fund Increased by $50,000

Supplementing a gift of Surface Combustion Corp. debentures with a face value of $46,000, three further gifts, in cash, have been made for the establishment of the Henry L. Doherty Memorial Fund. The Cities Service Co. has contributed $25,000; the W. Alton Jones Foundation, Inc., $15,000; and the Fruehauff Foundation, $10,000. It is understood that the principle of the Fund is to remain inviolate, only the income being used for designated purposes related to the petroleum industry. ★ ★

Visit the new offices of the Petroleum Branch, AIME, now located at 800 Fidelity Union Bldg., junction of Bryan, Pacific and Akard streets, Dallas, Tex.

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The JOURNAL will post notices of men and jobs available. Companies and AIME members are invited to use this space, for which there is no charge. Except as noted below, address replies to: Code (appropriate number), JOURNAL OF PETROLEUM TECHNOLOGY, 800 Fidelity Union Bldg., Dallas 1. Show return address on envelope. These replies will be forwarded unopened and no fees are involved.

Replies to the positions coded Y8005, Y7991, Y7835 and Y7768 below should be addressed to: Engineering Societies Personnel Service, 8 West 40th St., New York 18, N. Y. The ESPS, on whose behalf these notices are published here, collects a fee from applicants actually placed.

POSITIONS

♦ Division geologist with Louisiana Gulf Coast regional subsurface experience required by sound, substantial company in New Orleans. In reply state salary expected and give details of experience and education. All replies confidential. Code 546.

♦ Wanted in Oklahoma by independent operator an experienced production man for completion and workover. Must be willing and able to stay on job. Give personal and job data, also salary required, in reply. Code 544.

♦ Young chemical engineer, physicist, or petroleum engineer, with PhD degree to direct research work in petroleum production engineering and teach cycling, pressure maintenance and related subjects. Give complete personal and educational history, enclose photograph and salary required. Apply to Department of Mining and Petroleum Engineering, The Ohio State University, Lord Hall, Columbus 10, Ohio.

♦ Technical writer, 25-35, for editorial staff of national industrial magazine. Should have engineering degree, preferably mechanical, with experience in petroleum or chemical manufacturing operations and with emphasis on equipment. Must be able to write clearly and cleanly. Experience in magazine or newspaper field helpful, but not essential. Duties will include editing and rewriting copy, and field trips to gather data for original articles. Salary open. Location, Ohio. Y8005.

♦ Structural engineer, 33-39, with five to ten years' broad experience in design and construction in both the structural steel and concrete fields. Should have a degree in civil or architectural engineering. Experience should be preferably in the engineering department of a petroleum refining or chemical company of a contracting firm constructing such facilities. Location, Maryland. Y7991.

♦ Maintenance design engineer, 25-30, chemical or mechanical graduate, with chemical or oil refining experience, to prepare plans and procedures covering plant maintenance and alteration in oil refinery. Salary, $4,800-$6,000 a year. Location, northern New Jersey. Y7835.

♦ Sales engineer, 35-40, with some knowledge of lubrication problems in the mill and factory trade. Will do some engineering as well as sales. Salary plus commission. Location, New York, New Jersey and Connecticut. Applicants from these areas preferred. Y7768.

PERSONNEL

♦ Petroleum engineer, 1952 graduate of Oklahoma University, age 33, desires position with progressive independent interested in secondary recovery. Presently employed. Code 181.

♦ Reservoir engineer, graduate with five years' experience combined with research, including PVT, secondary recovery, consulting, oil and gas property evaluation, presentation of data before Federal Power Commission and Railroad Commission. Married, age 28, presently employed in supervisory capacity in Texas. All offers acknowledged. Code 182.

♦ Graduate petroleum engineer, University of Oklahoma, age 27, with two years' field experience in production services, desires change. Primarily interested in evaluation work or administrative position preferably in eastern part of United States. Code 183.

♦ Production engineer and superintendent, graduate O. U., 20 years' experience all phases engineering, well completion and production operations, desires change. Prefer production supervision, Oklahoma; other offers considered. Can furnish excellent references. Code 184.

♦ Qualified exploration manager, experienced in U. S. and foreign leasing, geological reconnaissance and petroleum exploitation engineering. Desires position with strong independent on salary, carried interest or similar basis. Optimistic attitude, with some fields discovered in areas favorably recommended, plus some immediate favorable areas, makes this an opportunity for an aggressive operator to increase his production quickly. Location immaterial. Code 185. ★ ★ ★

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Water Injection Projects

Continued from Page 12, Section 1

mainly of chlorination for killing bacteria and a filter to remove fine solids from the water. Since the entire reservoir to be subjected to this program is owned by British-American as lessee, and Tribal authorities as lessor, there is no necessity for cooperative agreements or unitization.

The reservoir is bounded on the east and north by the oil-water contact. It is bounded on the west by a fault and on the south by a permeability barrier, either a fault or a low-permeability segment.

SOME MAJOR ENGINEERING PROBLEMS

Water Supply

It is very important before commencing physical construction work of plant and water injection systems that adequate water supply is assured. Several instances have been observed in which projects have been delayed, or even decided against, because of inability to find a convenient and adequate source of water.

Use of Pilot Projects

Before embarking on an expensive water injection project, an engineer should have very convincing evidence from analysis of core data and past reservoir performance, or must prove to himself and his superiors the feasibility of such projects by actually trying water injection on a small scale. It should be borne in mind, however, that in testing a sand for water injection, a one-well program is not always fully effective. A much more reliable indication can be obtained by a five-spot pattern using four input wells surrounding one producing well. By this means, a definite measure of the recoverable oil within the square formed by the injection wells can be noted. If successful, such a pilot can then be expanded by adding additional five-spot locations.

Conversion of Old Producers for Input Service

Most experts on water-flooding advise against the conversion of old producers into injection wells. They prefer that new injection wells be drilled in most cases. However, if economics are marginal, money can be saved in some instances by converting wells, and it may be wise to try conversion on a few selected wells to determine advisability of converting additional wells.

Proper Water Conditioning

Injection water must be conditioned to prevent undue corrosion of equipment and to prevent excessive plugging of the injection zone.

There is a great need for a positive and direct method of checking corrosion rate before it has progressed too far. This may be approached by means of iron content tests of the water. An increase in iron content from the water source to the injection well gives an approximate index to the amount of steel that is being removed from the equipment by the action of the water.

Another method of measuring corrosion rate consists of using accurately weighed iron coupons. These coupons are placed in the water system and periodically removed for weighing to determine loss of weight caused by action of the water on the iron sample.

Even though both of these methods of measuring rate of corrosion seem to have a logical basis, it has been observed that they are not always entirely reliable. Some of the unreliability can probably be attributed to careless methods of chemical analysis in the laboratory. By the very nature of both methods, the procedure of chemical analysis and weighing must be extremely accurate. In one instance, on the basis of both iron content tests and iron coupon tests, the conclusion had been reached that corrosion rate was negligible. However, after a few months of operation, injection line leaks began to occur very frequently. After much head-scratching and re-examination of analytical laboratory tests, it was decided that more care should be used in the laboratory procedure and that certain features of the procedure needed revising.

SUMMARY

1. Displacement by water is, at present, the most effective known method of securing maximum amount of oil from a given volume of the average oil reservoir. This displacement process can sometimes occur as a result of natural forces, but often needs to be supplemented by a man-made water-injection program.

2. Under certain conditions, it is advantageous to inject water early in the life of a field in order to secure secondary oil concurrently with primary oil, thus avoiding an extended operating life and resultant higher operating cost.

3. In most instances, unitized operation will permit greater flexibility and more economical recovery. On the other hand, cooperative projects are sometimes advisable in order to permit quicker development of a water-injection program. Uniformity of ownership over an entire reservoir will obviate the necessity of either a unitized or cooperative endeavor. ★ ★ ★

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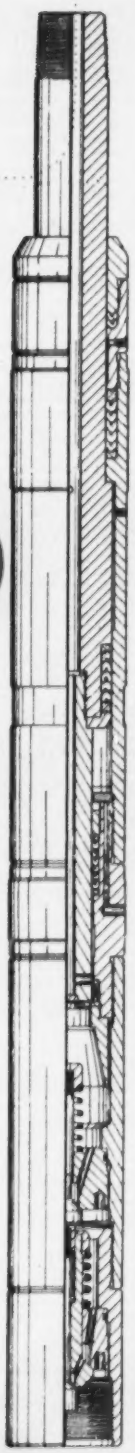

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ARTICLE VIII of the By-Laws adopted March 20, 1947, provides that:
". . . To be eligible for election to the Executive Committee a member shall have had wide experience in the affairs of the Branch . . ."
". . . To be eligible for Chairman a member shall have three years of active service in the Branch, at least one of which shall have been as Chairman of a standing or special committee or as a member of the Executive Committee . . ."
". . . To be eligible for Vice-Chairman a member shall have had two years of active service in the Branch, at least one of which shall have been as chairman of a standing or special committee, or as a member of the Executive Committee, or a Chairman of a Local Section . . ."

The list below is of members who meet the specific provisions of eligibility for election to Chairman or Vice-Chairman. No attempt has been made to distinguish those who meet the non-specific portion of the eligibility requirements, i.e., "wide experience" and "three years of active service." Data after each name represent the year and type of service, according to the code below.

The Pacific Petroleum, Wyoming Petroleum and Illinois Basin Chapters have been considered Local Sections, within the intent of the By-Laws. The list may be incomplete with respect to the earliest years of the Branch (1922-1927), as full records on that period are not available. Please call any errors or omissions to the attention of the editor.

POSITION CODE

A	Chairman, Advertising	PP	Chairman, Papers and Programs
AC	Associate Branch Chairman	PR	Chairman, Production Review
BT	Branch Treasurer	Pro	Chairman, Progress
Ch	Branch Chairman	Prod	Chairman, Production
CLS	Chairman, Local Section	PT	Chairman, Production Technology
EC	Member, Executive Committee	Pub	Chairman, Publications
Ec	Chairman, Education	RE	Refinery Engineering
Eco	Chairman, Economics	RVC	Branch Regional Vice-Chmn.
EE	Chairman, Engineering Education	SA	Chairman, Student Activity
ER	Chairman, Engineering Research	SC	Chairman, Special
Ge	Chairman, Geophysics	ST	Branch Secretary-Treasurer
Lc	Chairman, Lucas Fund	St	Chairman, Stabilizing
Me	Chairman, Membership	TC	Chairman, Technology
Nom	Chairman, Nominating	TE	Transportation Engineering Chairman
PE	Chairman, Production Engineering	VC	Branch Vice-Chairman
PG	Chairman, Production Geology		

Akins, D. W., Jr. ..... CLS 47
Alcorn, I. W. ..... Me 45 CLS 44 Ch 48 EC 48-49 Nom 49
Ambrose, A. W. ..... CLS 27 EC 30-35 Ch 28
Andrews, Paul ..... CLS 49 EC 49 VC 50
Armstrong, E. B. ..... CLS 47
Atkinson, Burton ..... CLS 48 Me 50
Atkinson, Thomas ..... CLS 47
Aucoin, Riley ..... CLS 45
Barkis, Bruce ..... A 52
Beal, Carlton ..... EC 46 ST 46 VC 48 EC 48 SC 47-48
Beams, Robert J. ..... CLS 48
Beardmore, H. F. ..... CLS 41 RVC 44 Ch 46 EC 45-46-47
Beecher, C. E. ..... AC 30 Ch 31 EC 32-37
Beesley, Jack H. ..... Me 51 CLS 52
Bell, John S. ..... PE 46 CLS 44 EC 51-52
Bennett, E. O. ..... EC 35
Berlin, E. W. ..... PR 51-52
Berwald, Wm. B. ..... CLS 45, EC 47
Bethancourt, Raoul ..... CLS 49
Bradley, R. J. ..... Ec 48-49
Brown, Bob Diggs ..... CLS 51
Brown, W. F. ..... CLS 50
Brownscombe, E. R. ..... Pub 48
Buckley, S. E. ..... CLS 42 PP 42 EC 44-45-47-48-49 AC 44
Busbee, J. M. ..... Me 43 CLS 43 Pub 51
Calhoun, J. C., Jr. ..... EC 49-51 Ec 52
Camp, R. W. ..... PE 32
Carter, D. V. ..... PR 50 EC 52
Churchwell, R. M. ..... CLS 50
Coberly, C. J. ..... AC 40 EC 41-42
Coburn, R. W. ..... CLS 51
Cooley, H. M. ..... CLS 50
Cordell, J. C. ..... CLS 52
Corless, G. B. ..... EC 37-38-39 Ch 38
Covell, K. A. ..... CLS 38 PE 44
Craft, B. C. ..... Ec 45 ST 38-39-40 EC 44 PP 44 EC 48-49-50
Crichton, Jack A. ..... CLS 51
Dahlgren, E. G. ..... PR 47-48-49
Decker, Harold ..... CLS 47 EC 49-50-51
Dooley, David L. CLS-47
Duce, J. Terry ..... Prod. 35-36-37-38-39-40-41
Dunlap, E. N. ..... CLS 49
Earlougher, R. C. ..... CLS 46 Pub 47 EC 50-51-52
Elkins, Lincoln ..... CLS 49 VC 51
Elkins, Lloyd ..... CLS 45 VC 47 EC 47-49-50 Ch 49 Nom 50
Estabrook, E. L. ..... EC 32
Field, J. H. ..... CLS 51
Fisher, Eugene A. ..... CLS 46
Fisher, Gordon M. ..... CLS 47 Pub 49
FitzGerald, Norman D. ..... Ec 42-43-44
Fitzgerald, P. E. ..... CLS 40 ER 42 Me 44 Pub 46 VC 48 EC 48
Fohs, F. Julius ..... Ch 25-26
Fowler, Harry C. ..... ER 32 EC 36
Frick, Tom C. ..... CLS 47-49 EC 51-52
French, Richard W., Jr. ..... PT 48 VC 50 Ch 51 Nom 52
Garrison, A. D. ..... ER 41
Gaylord, E. G. ..... EC 35 Nom 39
Geis, W. H. ..... AC 38 EC 39-40-41 Ch 39
Gill, John D. ..... EC 45-46
Gilmore, R. B. ..... BT 50
Glenn, Wayne E. ..... CLS 52
Gouldy, Roland ..... CLS 50
Granberry, R. C., Jr. ..... CLS 50
Gray, George R. ..... CLS 52
Graybeal, J. W. ..... CLS 45
Greenidge, S. M. ..... EC 39
Griswold, E. H. ..... PE 31-32
Haider, M. L. ..... PE 38 Pub 43-44 EC 43-45-46 Ch 45 Nom 46
Halbouty, M. T. ..... CLS 39 Me 40
Hamilton, R. G. ..... CLS 43
Hamman, Cecil A. ..... CLS 49
Hammond, John P. ..... CLS 49 Pub 52
Harlan, Don L. ..... CLS 49
Haynes, W. P. ..... Prod 43-44
Hayward, J. T. ..... ER 36
Heithecker, R. E. ..... BT 51
Herald, Frank A. ..... Prod 33-34
Heroy, W. B. ..... EC 39-40-41-43
Hess, Robert M. ..... CLS 45
Higgs, Morton T. ..... CLS 45
Hill, H. H. ..... ER 30
Hill, Kenneth E. ..... Eco 52
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Holmes, Joseph A. ..... CLS 47
Holsapple, L. W. ..... CLS 52
Howard, Raymond E. ..... CLS 52
Huntington, R. L. ..... ER 37-38
Jackson, Warren J. ..... CLS 48
Jones, N. N. ..... CLS 41
Kantzer, Basil ..... CLS 51
Katz, D. L. ..... ER 39-40 PP 43 Ed 46-47
Kaveler, H. H. ..... ER 45 PP 46 EC 46
Kelly, R. B. ..... EC 37-42 AC 41
Kelly, R. B., Jr. ..... CLS 52
Keplinger, C. H. ..... CLS 37 PE 42 RVC 46 EC 46
Kingman, D. G. ..... CLS 51
Kipp, Earl M. ..... TC 51
Knappen, Russell S. ..... EC 32-34
Knowlton, D. R. ..... EC 38-41
Kraus, Edgar E. ..... PG 47
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Langford, C. M., Jr. ..... CLS 40
Leeton, H. B. ..... CLS 50
Lehnhard, Phil J. ..... CLS 50
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Little, W. N. ..... CLS 50
Loomis, A. G. ..... ER 44
Love, R. W. ..... CLS 50
Loveiay, John M. ..... Ch 27 LC 32-33-34-35
Lund, Richard J. ..... EC 51
Lyle, Henry ..... CLS 48
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McMillan, John ..... CLS 47 EC 50-51 VC 52
Mercier, V. J. ..... CLS 49
Millikan, C. V. ..... Ch 30 EC 33-36-40 Nom 38
Moore, Jack M. ..... CLS 51 Me 52
Moore, R. V. ..... ER 35 PE 37 AC 39 Ch 40 EC 41
Morris, W. S. ..... CLS 40 PP 40-41 EC 43-44-45 AC 42 Ch 44 Nom 45 SA 52
Moulton, Gail F. ..... Prod 45-46 VC 49
Murrell, John H. ..... CLS 46 VC 47 EC 47-48-49-50
Muskat, Morris ..... PT 50 VC 52
Naramore, Chester ..... EC 44-45
Nowels, K. B. ..... ER 33
Nye, George L. ..... CLS 48
Ogden, L. A. ..... CLS 35
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Parsons, B. E. ..... EC 34
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Pogue, J. E. ..... Ec 27 Ec 32
Pollard, Terry A. ..... Me 48 ER 49
Porter, L. E. ..... PE 43
Porter, W. W. II ..... CLS 47 EC 47-48
Posgate, James ..... CLS 48
Power, H. H. ..... PE 34 EC 35-36-40-51 Ch 35 Me 37 Nom 41 Ec 43-44
Powers, W. D. ..... CLS 50
Putnam, Murray ..... CLS 50
Pyle, H. C. ..... Ch 47 EC 47-48 Nom 48
Ragland, Douglas ..... TC 52
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Schultz, Paul ..... Eco 50
Sheldon, Dean H. ..... CLS 48 EC 49-50-51
Shepherd, Jack M. ..... CLS 49
Sherborne, John E. ..... ER 46 EC 47-48-49-51 SC 46-47 VC 49 PT 49 Ch 50
Simmons, Fred E., Jr. ..... CLS 50
Smith, Roy H. ..... CLS 50
Smith, Veleair C. ..... AC 43
Spice, W. H., Jr. ..... CLS 51
Spoor, H. C., Jr. ..... SC 49
Stephenson, Eugene A. ..... PE 32 ST 33-37 inc., EC 34-39-40-41-42-43 PP 38 Ch 41
Stiles, William E. ..... BT 52
Stolz, Harry P. ..... AC 41 Ch 42 EC 43 Pro 45
Struth, H. J. ..... EC 32-47
Suman, John R. ..... EC 32-33-34
Swanbeck, L. W. ..... CLS 52
Swensrud, Sidney A. ..... Ec 35-36-37-38
Teague, J. U. ..... CLS 41
Terry, L. F. ..... EC 39-40-41
Thies, Roland K. ..... CLS 52
Thornton, Owen ..... CLS 49 Pub 50

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Officership Eligibility List

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Thronson, Lee J.	CLS 51
Trostel, E. G.	ER 43 PE 45 CLS 45
Turnbull, Paul	CLS 47 VC 51 Ch 52
Umpleby, J. B.	PE 27 Ch 29 EC 32-47 SC 46
Uren, Lester C.	Ed 48
Van Duzee, E. N.	EC 52
Vance, Harold	PP 39 EC 41-42 ST 43-44
Vaughan, Harry D.	CLS 52
Vietti, Wm. V.	CLS 37 EC 47-48
van Wingen, N.	PT 47 CLS 50
Walker, A. W.	CLS 39 PE 41
Waddill, Alfred W.	Me 46 CLS 51
Warner, C. A.	CLS 38 Me 39-41 AC 42 Ch 43 EC 44 Pro 46
Waszkowski, Henry	CLS 50
Watson, C. P.	AC 43, Prod 30
Weaver, P.	EC 39 Me 42 Ge 45-46
Wilcox, Stanley W.	CLS 44
Wilde, H. D., Jr.	PE 33 EC 33-34-35 Ch 34
Wrather, W. E.	EC 33-34 Ch 33
Wright, J. K., Jr.	CLS 51
Yates, G. L.	CLS 51 EC 52
Young, C. M.	EE 32-33
Zavoico, Basil	Prod 42 AC 43 RVC 43

Water Flooding in Kansas

Continued from Page 14, Section 1

shot on completion. No new oil wells have been drilled since water flooding commenced.

Water for flooding was originally obtained from a supply well drilled to the Douglas sand. This source became inadequate in February, 1952, when injection was commenced into the 12 new injection wells. At that time an Arbuckle water supply well was placed in operation. This well is equipped with a 135 hp Reda pump set at 843 ft in 4-in. tubing.

Arbuckle water is mixed with produced water and the mixture is first aerated to remove iron, hydrogen sulphide and carbon dioxide. Next, approximately one lb of lime per 10 bbl of water is added by means of a chemical feeder-mixer. Effluent from the feeder-mixed goes to an asphalt-lined earthen pit where iron and excess carbonates settle out. The pit is designed to provide three days' settling time based on an anticipated maximum water volume of 25,000 B/D. Present water volumes allow sufficient retention time so that no coagulent, such as alum, is needed. No algaecide is needed at present.

From the settling pit the water flows by gravity through four filter tanks containing anthrafilt as a filtering medium. The filter effluent goes into a 1,000-bbl clear tank from which it is pumped into the formation by means of three Oilwell 46-P triplex pumps.

Pertinent figures for the Beal Unit as of Sept. 1, 1952, are as follows:

Oil production, B/D — 2,784
Water input, B/D — 9,570
Cumulative water flood production, gross bbl — 345,674
Cumulative water flood production, bbl per developed acre — 2,259
Cumulative water input, bbl — 2,904,683
Cumulative water input, bbl per developed acre — 18,985
Acres developed — 153
Acres responding to water flood — 132.5
Number of active oil wells — 59
Number of active water input wells — 13

Development now in progress consists of 14 new input wells to be drilled, seven producers to be converted to input and one new oil well to be drilled. Completion of this development will place 373 acres under flood and leave 107 acres yet to be developed. ★ ★ ★

Comments on Capillary Equilibrium

Continued from Page 18, Section 1

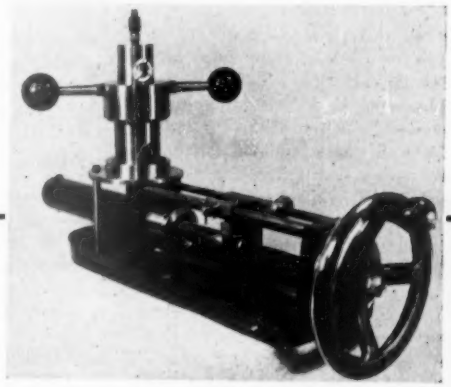
unequal curvatures. This explains why positive equilibrium imbibition displacement pressures are obtained in water-air systems, but not in water-oil systems. The rate of diffusion is much faster in the former. This also suggests that in liquid-liquid systems imbibition equilibrium curves cannot be obtained over practical periods of laboratory time unless flow through the wetting phase residual is possible in order that the pendular rings may grow to keep pace with the curvature of the imbibed interface. As Rose suggested, therefore the physical meaning of curves as Welge obtained is obscured until a different mechanics of pore entry is postulated.

ACKNOWLEDGMENT

The writer wishes to express his gratitude to J. C. Calhoun for his aid in the elaboration of this Note. The ideas presented developed during informal discussions with the staff at The Pennsylvania State College; in this respect, the comments made by C. R. Killins were of special value.

REFERENCES

1. Rose, W.: "A Note on the Application of the Capillary Pressure Method for the Determination of Oil Recovery," *Trans.* AIME, (1949) **186**, 325.
2. Purcell, W. R.: "Interpretation of Capillary Pressure Data," *Trans.* AIME, (1950) **189**, 369.
3. Welge, H. J.: "Displacement of Oil from Porous Media by Water or Gas," *Trans.* AIME, (1949) **179**, 133. ★ ★ ★



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Pigott Now President of Engineers Joint Council

R. J. S. Pigott, a consultant to the Gulf Research and Development Co., is the newly elected president of the Engineers Joint Council. In other recent action, T. A. Marshall, Jr. was appointed permanent secretary of the Council and Thomas H. Chilton was named chairman of the Council's Engineering Manpower Commission.

Pigott was recently retired as chief engineer, director of the engineering division in charge of engineering research for Gulf Research and Development Co. A mechanical engineering graduate of Columbia University, where he later taught, he has had wide experience in design, construction and operation of central steam power stations and industrial plants. He has served as president of the American Society of Mechanical Engineers, the Society of Automotive Engineers, the American Society of Measurement and Control and the Instrument Society of America.

Marshall is the first permanent secretary to be appointed by the Council. Formerly the office rotated among the secretaries of the five constituent societies, the ASCE, AIME, ASME, AIEE and AIChE. A graduate of Georgia Tech, Marshall was formerly with the Metropolitan Life Insurance Co. In his new position, he will also continue to serve as executive secretary of the Engineering Manpower Commission, which was organized by the Council in 1950 to analyze and offer solutions to the engineering manpower shortage.

Chilton, the new chairman of the Engineering Manpower Commission, is technical director of the engineering department, E. I. du Pont de Nemours Co. Chilton graduated as a chemical engineer from Columbia University in 1922, and joined du Pont in 1925. He is a past president of American Institute of Chemical Engineers and a former vice-president of Engineers Joint Council. ★

Transfer to Junior Grade Made Automatic

To facilitate transfer of Student Associates to the grade of Junior Membership in the Institute, all present requirements as to formal application were removed by action of the Directors at the December meeting of the Executive and Finance Committee. During the past year, to effect the transfer it has been necessary for the Student Associate to make out a formal application and have it endorsed by a member. Even though this was not a formidable handicap to the change of status, many Student Associates did not take the trouble to make application and were therefore dropped from the rolls at the end of the year of graduation.

It was voted "that effective in 1953, Student Associates shall automatically become Junior Members at the end of the year in which they finish school; that they shall be so advised at an appropriate time and be billed for Junior Member dues for the following year. No formal application or endorsements shall be required. If acceptance of election is not received by March 31, the Junior Member thus elected will be dropped."

Student Associates who were required to change status by Dec. 31, 1952, do not come under the new ruling. ★ ★ ★

15 Stanolind Fellowships To Be Given in 1953-54

Thirteen colleges and universities have been awarded a total of 15 Stanolind Oil and Gas Co. fellowships for the 1953-54 academic year.

The schools and the fields of research in which the grants will be made are: University of Colorado, geology; Columbia University, geophysics; Louisiana State University, chemistry and paleonthology; Oklahoma A&M College, mechanical engineering; University of Oklahoma, petroleum engineering; Pennsylvania State College, petroleum engineering; University of Pennsylvania, accounting; Rice Institute, chemical engineering; St. Louis University, geophysics; Texas A&M College, petroleum engineering; University of Texas, geology and petroleum engineering; University of Tulsa, petroleum engineering; Yale University, geology.

Each fellowship carries a stipend of $1,500 as well as tuition and fees. The stipend has been increased $250 over last year. ★ ★ ★

Frederick H. Lahee To Receive Powers Medal

Frederic Henry Lahee of Sun Oil Co., Dallas, Tex., has been named recipient of the Sidney Powers Memorial Medal of the AAPG for "his outstanding achievements in and continuing contributions to the field of petroleum geology as an educator, author, skilled administrator and executive, and as a pioneer in the gathering and use of hydrocarbon reserve and exploration data."

This highest honor in petroleum geology is named in honor of the late Sidney Powers of Tulsa, 14th president of the AAPG. Only six other geologists have received this coveted gold medal. They are Wallace E. Pratt, 1945; Alexander Deussen, 1947; A. I. Levorsen, 1948; E. DeGolyer, 1950; the late Max Steineke, 1951; and K. C. Heald, 1952.

Lahee was born in Hingham, Mass., and obtained his formal education at Harvard, receiving the PhD degree in 1911. He taught at the Massachusetts Institute of Technology, 1912-1918, and during this period published the widely-used handbook, "Field Geology," which has gone through several editions.

Lahee joined hte geological staff of Sun Oil Co. in 1918, and became chief geologist in 1920. He is also active in the American Petroleum Institute and has served on the Institute's committee on crude oil reserves since 1936, serving as its chairman since 1946.

Lahee was elected editor of AAPG in 1929, and continued to serve, through re-election, until 1932, in which year he was elected president. His committee work has included Research, Applications of Geology, Publication, Statistics on Exploratory Drilling, and most recently, Radioactive Mineral Exploration. He has served as chairman of all these committees. ★ ★ ★

Nominating Committee Changes Announced

The following changes in the personnel of the Nominating Committee for AIME Officers in 1954 were made by the Executive and Finance Committees at their meeting on Dec. 17: Robert H. Ramsey in place of Francis Cameron as alternate, representing the New York Section; J. A. Morris as representative of the East Texas Section, P. J. Lehnhard and R. K. Thies having stated that they could not attend the meeting in Los Angeles. Ramsey's address is care *Engineering and Mining Journal*, 330 W. 42d St., New York 18, N. Y., and Morris's is P. O. Box 312, Kilgore, Tex. ★ ★ ★

A REVIEW OF . . .

Oil Scouts' 1951 Field Development Volume

By R. B. Gilmore

Filled with facts, figures, maps, and charts, the annual review of Oil and Gas Field Development in the United States and Canada for 1951 has again been issued by the National Oil Scouts and Landsmen's Association. The current momentus volume of 994 pages has become a handbook of reference material on most of the various phases of operation of the petroleum industry as it affects activity in all but 13 of the states and in Canada.

As in the past, statistics assembled and reported by members of the Scouts Associations that cover these areas have been correlated and compiled into one volume by E. J. Raisch, Assistant Editor, Austin, Tex., under the supervision of Editor-in-Chief William H. Winckler, Scout, Magnolia Petroleum Co. An insight into the amount of work which this volume represents may be gained by the fact that more than 1,000 active members of the Association contributed information to the 32 groups which prepared the basic data for publication.

For each state or major oil-productive area, statistics are presented on completions during 1951, with important dry holes, successful wildcats, and field extension wells listed in detail. Production data are listed by fields both for the year and cumulative to Jan. 1, 1952. These figures are obtained from pipeline run reports of the various companies and from the state regulatory bodies.

An important phase of activity of the Scouts Association is keeping up-to-date with leasing and geophysical operations which are listed in detail in the areas where exploration continues to maintain the high rates attained during the last few years in the search for new areas of production and additions to reserves of oil and gas. Refining and pipeline operations during 1951 are reported as well as information on natural gasoline and cycling plants.

Of particular value to the industry is the forecast for the following year of leasing, geophysical, and other exploratory activities which indicates the major areas receiving the bulk of expenditures budgeted by the companies and independents. Maps of the states and areas, brief notes on the geology, and nomenclature charts correlating ages of the locally-named sedimentary horizons encountered round out the coverage of the many individual papers.

In addition to these valuable statistics compiled by members of the Association, the book contains reprinted articles such as the American Petroleum Institute's general review of oil and gas for 1951, Frederic H. Lahee's American Association of Petroleum Geologists Committee report on statistics of exploratory drilling in 1951, and summary tables from the joint report of the American Petroleum Institute and the American Gas Association on proved reserves of crude oil, natural gas liquids, and natural gas. The book ends with a roster of active and associate members of the Association.

As a source book on statistics of the petroleum industry, this volume contains data unobtainable from any other source even by many in the industry. The annual reviews published by the National Oil Scouts and Landsmen's Association remain valuable references throughout the years and are a basic part of the historical record of oil and gas operations in the United States. ★ ★ ★

AIME Announces Two New Books—

Problems of Clay and Laterite Genesis

A collection of authoritative articles on the occurrence, identification, and genesis of clays and the hydroxide minerals of aluminum and iron. The scope of the volume ranges from prospecting techniques through interpretation of X-ray and other experimental data. For both practical and research purposes this book is a must for geologists.

Published 1952 *252 pages*
$4.20 to AIME Members
$6.00 to Non-members

Gasification and Liquefaction of Coal

For all fuels technologists, this book appeals as a composite of current world-wide status of the synthesis of liquid fuels from coal. It is a collection of articles presented by authorities in the field from all over the world. Factual data on pilot plant and commercial operation are included as well as papers reviewing technology and economics.

Published 1952 *240 pages*
$4.20 to AIME Members
$6.00 to Non-members

American Institute of Mining and Metallurgical Engineers
Box CC **29 W. 39 Street** **New York 18, N. Y.**

Book Reviews

Problems of Clay and Laterite Genesis

A Symposium, American Institute of Mining and Metallurgical Engineers, New York, N. Y., 1925, $6.00, $4.20 to AIME members, 240 pp., 6 x 9, cloth bound.

A composite volume for practical and research purposes, this book discusses basic problems in terms of occurrence, identification, and genesis of clays and the hydroxide minerals of aluminum and iron. In scope it ranges from prospecting techniques to interpretation of *X*-ray and other experimental data as related by experts in the field from here and abroad.

Problems of clay-mineral identification and genesis are discussed with special attention to limitations of various instruments and techniques: differential thermal, *X*-ray, electron microscope, and others.

Genesis of famous clay and bauxite ores of Arkansas, Pennsylvania, and Missouri is reviewed individually, marshalling much new information. Recent work on the equilibrium relationships in the system Al_2O_3–H_2O is presented and the genetic significance of the results contrasted with those obtained from field studies of these ores.

This authoritative volume outlines the frontiers of knowledge of the applied, economic, and research aspects of clays and related hydroxide minerals. ★ ★ ★

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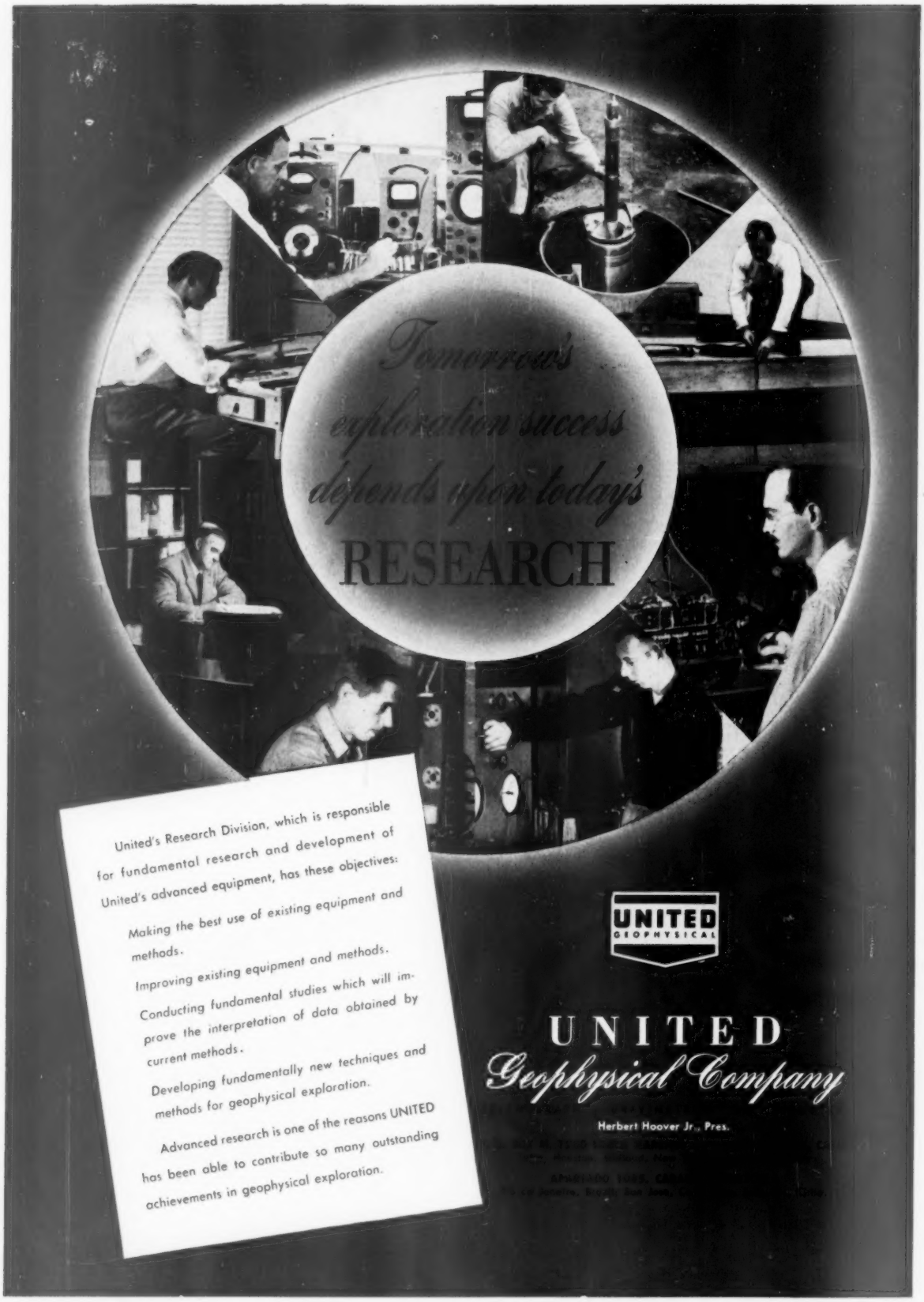

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